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INDEX TO SUBJECTS AND AUTHORS ON PAGE 495

Nitrate Production Under Field Conditions in Soils of Central Alberta.

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It is a common observation in our northern latitudes that crops show a very rapid and astonishing growth especially during the summer months. This is thought by many to be due to the great amount of sunshine that accompanies the long summer days. However, it occurred to us that the extremely fertile conditions of the soils together with a climate which has its period of greatest rainfall coinciding with the summer season and crop growth might at least be a contributing factor to the rapidity of growth. Therefore, it was decided to study the effect of climate upon the rate of nitrate and ammonia production under field conditions where various crops and cultivation methods were employed. Thus in the spring of 1923 systematic plans were outlined in order that we might find out what relationships existed between microörganic activity and crop production in our soils. These experiments have been conducted for the past three years and will be extended next year to include other parts of the province.

The present paper however will be confined to the production of nitrates during the years 1923 and 1924. Previous to this paper no comprehensive nitrification studies have been reported for Alberta soils.

Soil

The plots under study are located at the University of Alberta Experimental Farm. The soil is a black loam very high in organic matter and virtually in its virgin state of fertility. It has been cropped only since 1918 at which time the poplar trees and bush were cleared and the land broken. The soil is not typical timber soil, but is prairie soil upon which the timber has encroached chiefly within the last hundred or two years. The soil on these plots may be said to represent the best soils in the black earth belt of Alberta described by one of us in a previous paper (22).

The following table containing partial analyses of the soils of the various plots under study gives some idea of their composition and properties.

These soils are all well supplied with potassium. This constituent varies from 1.7 to 1.9 per cent. with the amount almost constant for the various depths, thus we have not included data for potassium in Table 1.

These soils are well supplied with plant foods, especially the nitrogen. Column 7 indicates that the organic matter in the soil is relatively active and should respond to microörganic activity. It will be seen later in the discussion that the rate of nitrate production is relatively rapid. The water holding capacity is relatively very high even for the lower strata. Moreover these soils are found to produce nitrates and ammonia very rapidly at moisture contents varying from 40 to 50 per cent. (water free basis).

Climate

The climate of this part of Alberta may be characterized by the dry cold winters during which no growth occurs and accompanied by virtually sterile soil conditions followed by the slow advancement of spring and the rapid advancement of summer. The summer season is accompanied by high daily temperature with long hours of sunshine and generally sufficient moisture to enable rapid preparation of plant food and astonishing crop growth. The total rainfall is on the whole rather light (about 17.0 inches average for 35 years, 1883-1917), but owing to the fact that at least 75 per cent. of it falls between April 1 and Sept. 30, during the growing season, it is more efficient in producing crops than would be the case provided a greater proportion occurred during the fall and winter seasons.

The lowest annual precipitation for the 35 years was 8.16 inches (1889). The highest annual precipitation for this period was 27.81 inches (1900). The average precipitation

TABLE I

Partial analyses of soils from various plots Campus and Experimental Fields, Edmonton (per cent composition, water-free soil)

Plot No.	Depth	Nitrogen	Phosphorus	Inorganic Carbon	Organic Carbon	Ratio C:N.	Water Holding Capacity
1-5	Surface	.61	.106	.0097	6.536	10.7	
1-7	"	.62	.110	.0088	6.093	9.8	
4-5	"	.66	.125	.0148	7.993	12.1	
4-7	"	.72	.133	.0118	7.740	10.8	
1-K	"	.68	.116	.0136	7.772	11.4	
1-L	"	.70	.129	.0134	7.839	11.2	
1-A	"	.63	.093	.0403	6.943	11.0	70
1-B	"	.60	.095	.0089	6.868	11.4	
8-A	"	.68	.084	.0125	7.552	11.1	
8-A	Subsurface	.24	.065	—	—	—	
8-A	Subsoil	.15	.75	—	—	—	
8-A1	Surface	.72	.128	.0138	7.953	11.0	
10-C	"	.73	.118	.0147	8.370	11.4	74
10-C	Subsurface	.30	.078	—	—	—	55
10-C	Subsoil	.14	.081	—	—	—	58
5-B	Surface	.67	.127	.0100	7.584	11.3	
5-A	"	.76	.108	.0134	7.713	10.1	78
3-A	"	.68	.086	.0140	5.922	8.6	
9-B	"	.70	.138	.0145	7.242	10.3	76

for the period was 17.42 inches. Seventy-five per cent. of the annual precipitation fell during the 6 months, April to Sept. inclusive and 63 per cent of the annual precipitation fell during the four months of active crop growth (May to August inclusive).

The mean temperature for the winter season is sufficiently low to inhibit microörganic activity and plant growth, and it might be expected that practically no vegetative growth took place during the months Nov. to March inclusive. In general this is true and the season of vigorous growth really extends from the early part of June to the latter part of September with an average frost free period of about 100 days.

Of course the soil temperatures will show slightly different extremes than the atmospheric temperatures, and the former will lag on the latter. However, the soil temperatures early in April and again in October are sufficiently low to retard in many cases microorganic activities, but on the other hand the maximum soil temperatures during the summer are never too high to inhibit such reactions. Some idea of the changes in soil temperatures during the months of April to October, may be obtained by referring to Fig. 7, in which the soil temperatures for 1923 and 1924 are plotted as curves.

Thus we see that the climatic conditions favour intensive and rapid growth for

period of the year coinciding with the greatest rainfall followed by dry cold weather which delays and often almost immediately prevents further decomposition and loss of organic matter and plant foods, until the following spring when temperature and moisture again permit the rapid preparation of foods for plants at a time when they are in greatest demand.

The above conditions have been responsible for the native vegetation of this district, and the vegetation in turn responsible for the organic matter and nitrogen content of the soils. With a warmer climate, higher rainfall would be required to bring the organic matter content of the virgin soils up to the level indicated by the data in Table 1.

History of Plots

The plots reported in the following paper have been subjected to cultivation and cropping, in general, only since 1918 At about this time most of them were broken from the virgin state. The plots of the Campus Field, however, have been tilled and cropped since 1916. During this period no fertilizers have been applied except to plots 1-7 and 4-7, each of which received one application of manure, acid phosphate and potassium sulphate, and plot 3-A which received one application of farm manure. Thus it may be said that the results herein reported represent the ability of the virgin soils of this district to produce nitrates under field conditions when subjected to different tillage and cropping systems.

Nitrate Production in Field Soils

The plots reported in this paper are located on the Campus and Experimental Fields of the Field Husbandry Department of the University. They were chosen so that we might have comparisons of the influences of various crop sequences and tillage operations upon the rate of plant food production under our climatic and soil conditions. It is a common observation that certain crop sequences give better yields than others and these observations seemed to us to have their explanation in the resultant of crop factors which includes temperature, moisture, and plant foods. Thus the soil temperatures were recorded during the entire sampling period and the moisture content of the soils was determined at each date of sampling for all samples taken.

It was found impossible to study the relationship existing between temperature, moisture, crop growth, and all the plant foods. Therefore, the rates of nitrate and ammonia production were used as the index of the rates of plant food production under the different crop and cultivation conditions.

The crops selected consisted of annuals such as wheat and barley for the untilled, corn and potatoes for the intertilled, bi-annual sweet clover, perennials such as timothy and alfalfa, together with summer fallow as representing the maximum plant food production.

Samples of soil were taken from the various plots above described at intervals of two weeks from the early part of May until about the time of freeze up. Each sample was a composite of 10 borings for the surface, and about one half as many for the lower strata. These samples were taken to the laboratory, weighed and immediately placed in the drying oven at 105°C. where they were left for 16 hours whereupon they were weighed and placed in air tight containers until analyzed.

Owing to the necessity for sampling all plots at the same time and the great number of samples it was impossible to analyze the samples immediately after collecting them.

These surface soils almost invariably give highly colored extract solutions, but no difficulty was experienced in clarifying them with aluminum cream. The method used for determining the nitrates was that described by Emerson (4). Fifty grams of soil were treated with 250 c.c. of water and 1 gram CaO, shaken for 10 minutes, allowed to stand for 30 minutes, then filtered through filter-paper. 25 c.c. of this filtrate was clarified with aluminum cream, filtered and washed, and then the usual procedure followed in the phenoldisulfonic acid method.

Results obtained by this method were found to check very closely with results obtained by taking the soil extract, first expelling the ammonia, and then determining the nitrates by reduction with Devarda's alloy.

Only the data for nitrates will be presented in this paper. The ammonia production will be discussed in a subsequent paper.

There has been a great amount of work conducted along the line of nitrification in soils but by far the greatest amount has been confined to laboratory experiments dealing with the soils as modified by temperature,

moisture, and fertilizer treatments. However, on the other hand, extensive researches have been conducted with soils in the field as influenced by rotation, treatment, cultivation etc. Such field experiments are reported by Albrecht (1), Brown (2), Fraps (5), Gowda (6), Hall (7), Jensen (9), King and Whitson (10), Lyon and Bizzell (12) Noyes and Conner (14), Russell (16), Stewart and Greaves (18) Whiting and Schwonover (20), and others.

In general the results of the above authors are confirmed by our data. However, it should be remembered that we are working with very fertile untreated virgin soils which would cause our minimum amounts of soil nitrates to be above the minimum reported by most of the authors above mentioned. Likewise our maximum nitrate contents are generally comparatively high.

The data for nitrate nitrogen found in soils of plots variously cropped and cultivated for the years 1923 and 1924 are found in Tables 2 and 3 respectively. For purpose of comparison these data are plotted in Figures 1 to 6. The data for certain plots are represented in the same graph for the two years, since this gives a better idea of the effect of crop sequence and cultivation upon the ability of the soil to produce nitrates. These figures likewise contain graphs of the mean daily soil temperature, and the rainfall distribution for the seasons during which soil samples were taken.

The data for nitrate nitrogen in p.p.m. for the various plots and dates of sampling for 1923 are recorded in Table 2. From this table it will be seen that the nitrate nitrogen in all plots on the first date of sampling (Apr. 20.) was relatively high; varying from 16 to 39 p.p.m. for the various crop sequences and tillage operations. The plots showed a general accumulation of nitrates during the early part of the season, and then a decrease usually rather rapid and dependent upon the condition of the crop growths occupying the plot. The nitrate content of these plots was relatively low during the season of most active growth of the crop, followed in general by a slight tendency toward accumulation after the crops were approaching maturity, and near the end of the season. At the first sampling in 1924 there was in general a further accumulation of nitrates in most plots.

The plots supporting perennial crops (1-A and 1-B) showed the lowest periodical nitrate contents and likewise the lowest seasonal average. These are followed by the annual crops with the summer fallow highest of all. The crops following an intertilled crop (corn) had access to more nitrates than those following a non-tilled crop (barley or wheat). Welton and Morris (19) found that the nitrate content of soils under potatoes was higher than that of soils under such crops as corn, oats, wheat, clover, or soy beans, and that the variation in nitrate contents developed as a result of the crop grown. However, there were smaller relative differences in this respect for our soils than have been reported by these and other investigators.

The summer fallow plot (10-C) and those either following summer fallow (5-B and 3-A) or a partial fallow (1-K and 1-L) allowed very vigorous nitrification especially during the early part of the season.

The column of averages for the season brings out the following interesting comparisons. The plots carrying crops whether perennial or annual, tilled or non-tilled varied from 9 to 20 p.p.m. of nitrate nitrogen with the timothy and alfalfa lowest, 9.2 and 11.9 p.p.m. respectively. The seasonal average for the timothy plot (1-B) was only about one half as great as for the plots producing such crops as barley or corn. Corn after potatoes (4-5 and 4-7) was approximately the same as corn after fallow (3-A) and both were higher than corn after peas (1-5 and 1-7). The seasonal averages for these plots were 19.5, 19.6 and 15.2 p.p.m. respectively.

The summerfallow plot (10-C) has a seasonal average of 37.4 p.p.m. nitrate nitrogen in the surface and 25.5 in the subsurface. The amount in the subsurface of this plot exceeds that of the surface soil of any of the cropped plots.

By comparing plots 1-L and 1-K Table 2, and 1-A and 1-B Table 3 it will be seen that the alfalfa residues in the soil promoted nitrification more vigorously and at an earlier date than did the timothy residues. A similar effect regarding the influence of legumes and non legumes upon the process of nitrification has been reported by Lyon and Bizzell (13), Whiting and Schwonover (20) and others.

TABLE 2

Nitrate Nitrogen in Soil under various Crops in 1923 (parts per million)

Block Plot	Stratum	Crop	Apr. 20	May 8	May 23	June 5	June 19	July 3	July 17	July 31	Aug. 14	Aug. 28	Sept. 11	Sept. 25	Oct. 8	Oct. 23	Avg.
1A	Surface	Alfalfa sown in 1922	24.0	38.7	16.1	12.4	7.7	9.3	16.1	4.0	4.1	5.9	8.4	6.7	7.1	6.0	11.9
1B	Surface	Timothy sown in 1922	16.2	15.0	14.4	15.0	4.2	7.4	13.1	4.4	5.5	3.6	7.3	7.5	8.4	6.8	9.2
1K	Surface	Timothy sod broken in 1922	38.6	32.0	35.1	23.5	21.5	11.8	8.2	13.3	4.1	8.2	7.6	7.8	11.9	14.0	17.0
1L	Surface	Alfalfa sod broken in 1922	37.0	35.7	44.9	34.0	32.3	16.2	11.6	9.2	4.0	10.2	5.9	14.3	12.2	15.5	20.2
8A	Surface	Barley after sunflowers	23.2	34.0	43.5	35.4	12.3	13.4	2.4	8.8	4.0	8.0	7.6	14.1	13.3	19.8	17.1
8A	Subsurface	“ “ “							2.7	3.4	1.5	2.4	2.9	4.0	4.4		3.0
8A	Subsoil	“ “ “							1.2	3.1	1.5	1.7		3.4	3.0		2.3
8A1	Surface	Barley after barley	36.7	43.4	37.5	23.5	16.3	10.7	3.4	4.7	3.0	10.9	7.3	13.5	10.9	12.3	16.7
10C	Surface	Fallow after grain crops	37.3	41.6	40.8	29.2	33.3	12.2	16.9	26.6	32.4	35.7	35.9	59.6	62.5	60.0	37.4
10C	Subsurface	“ “ “							20.7		27.0	28.3	34.0	19.0	24.2		25.5
10C	Subsoil	“ “ “							1.9		3.6	7.8		3.8	7.5		4.9
5B	Surface	Sweet clover after fallow	39.3	47.1	40.6	27.0	30.3	19.5	12.3	6.6	15.6	7.5	7.0	9.0	7.4	6.8	19.7
5A	Surface	Wheat after timothy 1922	38.5	48.0	48.2	35.7	10.1	14.1	3.0	4.0	7.6	9.2	8.7	9.7	10.7	12.4	18.6
3A	Surface	Corn after fallow 1922	24.0	50.5	55.3	28.1	22.0	17.5	11.8	5.2	13.0	9.1	5.6	7.1	8.1	17.6	19.6
1 5	Surface	Corn after peas 1022	22.9	30.1	31.3	22.4	20.5	17.7	11.8	8.2	9.4	12.1	6.9	8.9	9.6	9.9	15.8
1 7	Surface	Manure P.K.	24.2	23.7	29.8	33.5	17.7	13.5	13.0	6.2	3.6	10.6	5.7	6.9	8.2	9.0	14.7
4 5	Surface	Potatoes after corn	30.0	40.8	40.8	34.2	32.2	16.1	16.0	5.4	3.4	5.4	6.7	9.4	11.5	12.4	18.9
4 5	Subsurface	“ “ “								8.1	8.7	4.9		2.7			6.1
4 5	Subsoil	“ “ “								3.5	2.4	2.7		1.9			2.6
4 7	Surface	Manure P.K.	37.5	32.8	50.0	38.1	34.8	15.9	13.0	3.6	9.0	4.7	12.7	5.6	13.6	10.2	20.1
4 7	Subsurface	“								4.5	2.7	1.7		3.6			3.1
4 7	Subsoil	“								5.0	1.9	1.6		1.8			2.6

TABLE 3

Nitrate Nitrogen in Soil under various Crops in 1924 (parts per million)

Block Plot	Stratum	Crop	May 12	May 26	June 9	June 23	July 7	July 21	Aug. 4	Aug. 18	Sept. 1	Sept. 15	Sept. 29	Oct. 14	Average
1A	Surface	Alfalfa	8.1	6.6	4.3	5.9	8.9	11.0	10.0	33.3	15.9	23.0	26.5	26.0	15.0
1B	Surface	Timothy	6.4	5.8	4.0	4.7	9.2	9.5	3.0	7.6	13.2	15.3	24.7	20.2	10.3
1K	Surface	Timothy after potatoes	19.2	18.1	26.8	37.5	47.6	19.8	2.8	4.6	4.5	8.1	4.6	9.3	16.9
1L	Surface	Alfalfa after potatoes	40.3	38.3	36.6	40.0	45.9	14.3	6.7	8.1	6.2	3.6	4.6	8.8	21.1
8A	Surface	Wheat & clover after barley	18.1	12.2	23.8	8.1	8.4	7.0	5.7	5.5	5.3	22.0	5.2	8.6	10.8
8A	Subsurface	“ “ “ “	4.3	7.1	7.0	4.7	5.7	3.5	4.8	2.3	2.3	2.5	3.4	5.2	4.4
8A	Subsoil	“ “ “ “	2.1	2.4	3.7	3.3	6.5	2.8	3.8	2.7	2.0	2.1	3.3	3.1	3.2
9B	Surface	Fallow after forage crops	19.7	13.5	19.2	25.0	58.8	40.0	18.9	38.0	17.9	24.6	22.5	20.0	26.5
9B	Subsurface	“ “ “ “	3.5	3.0	6.1	10.9	14.4	10.3	19.8	12.6	14.0	14.6	21.4	18.9	12.5
9B	Subsoil	“ “ “ “	3.2	3.2	2.8	3.8	7.8	2.7	2.4	3.5	3.6	12.8	6.0	5.7	4.8
10C	Surface	Wheat after fallow	65.2	56.3	65.0	25.1	12.2	12.9	10.5	11.4	8.1	12.9	4.9	8.3	24.4
10C	Subsurface	“ “ “	30.0	34.5	22.5	18.8	25.0	12.2	11.8	11.6	9.8	8.3	15.8	13.9	17.8
10C	Subsoil	“ “ “	8.8	12.5	18.3	14.3	18.3	8.4	5.9	7.3	2.9	2.4	3.7	5.4	9.0
5B	Surface	Sweet clover pasture after sweet clover	13.3	10.3	8.1	8.5	7.4	5.8	11.7	37.7	30.7	32.0	23.3	29.2	18.2
5B	Subsurface	“ “ “ “	4.1	8.7	5.2	5.3	3.7	3.0	8.9	7.4	6.5	9.7	5.4	13.5	6.8
5B	Subsoil	“ “ “ “	4.7	3.0	4.7	2.0	2.5	2.5	2.1	4.1	2.7	2.7	2.3	2.1	3.0

The corresponding data for nitrate nitrogen for the above plots for the season of 1924 are recorded in Table 3.

On the date of first sampling (May 12) in 1924, the plots in general contained nitrate nitrogen in excess of the amounts present on the date (Oct. 23) of last sampling in 1923. However, nitrification probably had been taking place before the date of first sampling in 1924, since the nitrate showed a general tendency to increase from Apr. 20th to May 8th in the soils of these plots for the season of 1923.

Table 3, containing the nitrate data for a number of plots for 1924, shows much the same relationships as pointed out for these same plots in 1923. The seasonal averages are similar and in the same order as observed in Table 2. However, the summerfallow in 1924 did not contain as much nitrate nitrogen as in 1923. That appreciable downward movement of nitrates occurred when the soil was fallowed may be seen by comparing the subsurface and subsoil of plot 9-B with these layers for one of the cropped plots (8-A). It will be seen that 10-C, which was fallowed in 1923 and supported wheat in 1924, contained rather large quantities of nitrates in the lower layers of soil even while the plot was supporting a vigorous growth of wheat, and that the seasonal average for the subsurface of this plot was about the same as for the surface soil of the plots which were likewise supporting crops, but which had not been fallowed during the previous years. It should be noted that the nitrates rapidly decreased in the surface soil after June 9 and not in the subsurface and subsoil until after July 7th. That the soil moisture as well as the demand of the crop has influenced the nitrate nitrogen in the various layers, especially of the summer fallow plots, may be seen by referring to the above tables, but this relationship is more clearly shown by the curves in Figures 2 and 6.

It is quite evident from the data in Tables 2 and 3 that the seasonal fluctuations in the nitrate content of the various plots is influenced to a great extent by crop sequences and cultivation. This influence is more clearly shown in Figures 1 to 4.

It is interesting to note that the process of nitrification in these soils proceeds very rapidly under summer fallow and apparently sufficiently rapidly under crops to meet the demands of the crop even though crops are grown every year. This condition is emphasized by the curves in Figure 5, which represent the nitrate nitrogen in pounds per acre to the depth of 40 inches.

It should be noted that the extreme variations in moisture contents for the surface soils of the various plots fluctuated from about 19 to about 57 per cent during the sampling periods of these two years, and that the lower moisture contents occurred in the soils under the perennial crops, whereas the highest soil moisture was found in the summer fallow plots. The fluctuations in soil moisture were in general parallel to and largely responsible for fluctuations in nitrates. However, in certain instances of high moisture contents in the soil a corresponding decrease in nitrates occurred, especially in the surface layer. As previously pointed out this lack of correlation is due to the leaching of some of the nitrates into the lower layers of soil.

The average moisture content of the surface soil of the various plots showed variations influenced by crop sequence with limits ranging from 27 to 48 per cent, the lowest average being for the soil under alfalfa and timothy and the highest for the summer fallowed soil. These figures appear to be high, but when it is understood that the water holding capacity (Table 1) of these surface soils is at least 70 per cent of the dry weight of the soil it is not surprising that nitrification will proceeed until the soil contains at least 40 to 50 per cent moisture and that downward movement of water is seen to take place only after the soil moisture has risen to the point of the latter figures.

It might be interesting to note that plant growth took place only very slowly when the moisture content of the soil was below 25 per cent.

From the organic carbon content of these surface soils it may be estimated that they contain at least 10 per cent of organic matter, thus their water holding capacity would be approximately 20 per cent higher than the subsoils as indicated by Table 1.

Fig. 1 shows the relationship between nitrates and moisture in soils under timothy, alfalfa and barley for the years 1923 and 1924. It will be noted that the timothy and

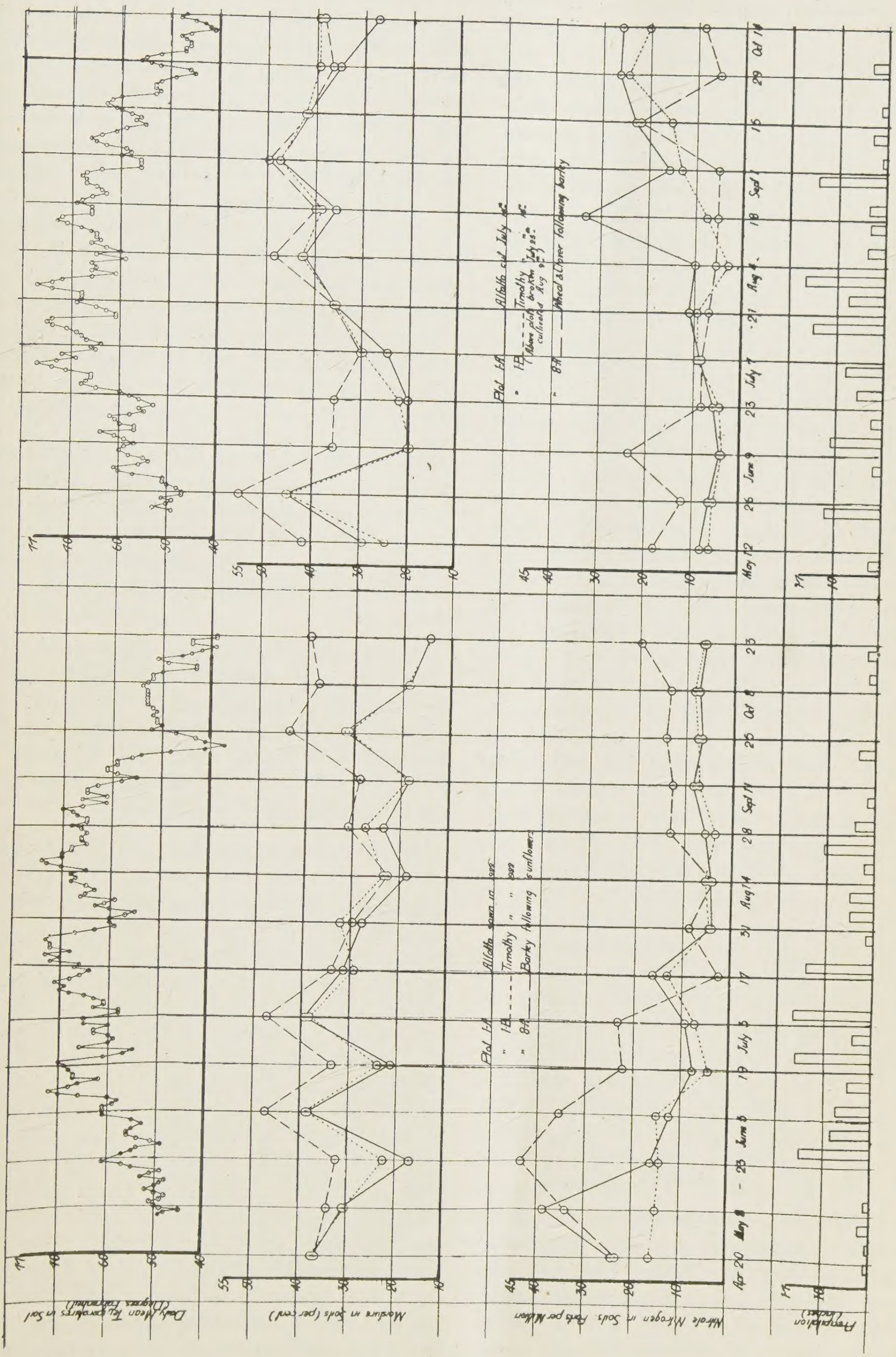

Fig. 1—Nitrate nitrogen and moisture in surface soil under various crops. Left (1923) under alfalfa, timothy, and barley; right (1924) under alfalfa, timothy and wheat and clover.

alfalfa, perennial crops, keep the nitrates and moisture lower than does the barley. This is especially so during the early and late part of the season at which times both of the former crops are using some moisture and nitrates owing to a certain amount of growth which was not affecting these constituents in the soil of the barley plot. However, on July 17, 1923 both the timothy and alfalfa plots showed increasing nitrates, whereas the barley plot showed the nitrates decreased to the lowest point of the season, less than 3 p.p.m. This is due to the fact that the barley was still making a heavy demand upon the nitrates, whereas the alfalfa and timothy crops had been cut about one week previous to this sampling. The second growth of timothy and alfalfa was cut on Aug. 27th, after which both these crops showed but a very short growth during the remainder of the season. The nitrates in these plots showed a slight tendency to increase immediately after the second crop was cut and then remained practically constant for the remainder of the season. However, on the other hand the nitrates in the barley plot tended to increase after Aug. 14th until the end of the season. The barley was harvested a few days before the sampling on Aug. 28th. The moisture in the soil after the barley had been harvested tended to increase towards the end of the season whereas it first increased and then rapidly decreased under timothy and alfalfa. That nitrates may accumulate at this season of the year is shown by the barley plot. The fact that they did not accumulate under timothy and alfalfa may be due jointly to the demand made by the small growth of these two crops together with the low moisture content of the soil. It should be mentioned at this point that the alfalfa and timothy had been sown only the previous year and that the nitrates are relatively higher than is the case where these crops have occupied the land for several seasons.

There had been practically no change in the nitrate content of these plots from Oct. 23, 1923 to May 12, 1924. However, the moisture content had increased somewhat, especially in the alfalfa and timothy plots. During the season of 1924 the nitrates under timothy and alfalfa were very much lower than under wheat and exhibited very little fluctuation as to amounts before June 23, after which date there was a rapid growth and a very slight increase in nitrate content until July 7, when all three crops showed the soils to contain about equal nitrate contents. The alfalfa and timothy were cut for hay several days previous to the sampling on July 25th. From Aug. 4th until the end of the season these plots showed increasing accumulations of nitrates and contained greater quantities than the wheat soil. The wheat was harvested early in September and by the 15th of the month the nitrates in the soil had risen from 5 to 22 p.p.m. These accumulated nitrates rapidly disappeared during the next two weeks, largely due to the growth of clover in the wheat stubble.

During the season of 1924 the nitrate curves for the alfalfa and timothy plots are exactly the reverse of that for the wheat plot. This is due to the comparative growths during the early part of the season and the breaking of the timothy and alfalfa plots during July.

The moisture curves for these three plots are in general parallel and influenced by the seasonal precipitation. However, the moisture content of the soils under timothy and alfalfa is lower than that of soils under barley or wheat. In this respect the moisture is analogous to the nitrates.

During certain portions of the season, especially when the plants are actively growing, the nitrates decrease simultaneously with the soil moisture; however, the nitrate curves are more constant than the moisture curves. Whiting and Schwonover (20) have reported like similarities for Illinois conditions. At the beginning and the end of the growing season the nitrates may increase or decrease with the fluctuation in soil moisture or just the reverse. This is more apparent in Figures 2 and 6, and is undoubtedly due to temperature and moisture, especially the latter, since the moisture content of these soils is at times sufficiently high to inhibit nitrification and even cause leaching into the lower depths. The water holding capacity of these surface soils at saturation is from 70 to 75 per cent, and if we assume that nitrification proceeds best at 50 to 60 per cent saturation we may expect a retardation of this process at moisture contents above 45 per cent.

In this and subsequent figures there seems o be a lag of the nitrate curve on the mois- ure curve. Russell (17) states this relation- hip virtually in terms of a law.

From these curves and those in Fig. 2 it is learly seen that the soil under the legume auses much more immediate and intense ni- rification than occurs under grasses such as imothy. This fact has been observed by ,yon (13), Whiting (20), and others.

Fig. 2 shows the relationship between ni- rate nitrogen and moisture in the surface oils under summerfallow, potatoes follow- ng timothy, and potatoes following alfalfa or 1923, and cereals following summer- allow, timothy following potatoes and lfalfa following potatoes for 1924. In the all of 1922 Plots 1-K and 1-L were in the ame condition as to crop sequence and cul- ivation as were plots 1-B and 1-A Fig. 1, n the fall of 1924. That is they were broken luring the late summer of 1922 and may be onsidered as summerfallow until potatoes vere well through the ground about the mid- lle of June 1923.

During the growing season the potatoes apidly reduced the nitrates until July 17, af- er which, aside from minor fluctuations, they emained fairly constant until about the mid- lle of September when the potatoes ripened apidly. The potatoes were dug during the lat- er part of September. The nitrates in the po- ato plots tended to increase at the end of the eason, but likewise showed a further accumu- ation on May 12, 1924.

The fluctuations in the nitrates under the ummer fallow were almost identical with hose under potatoes until July 3, after which hey increased until the end of the season vhen they had accumulated to the extent of 0 p.p.m. of nitrate nitrogen as compared vith 15. p.p.m. for the potato soils.

The rapid decrease in the nitrates of the sur- ace soils of all three plots from May 23rd o July 3rd accompanies similar rapid in- reases in the soil moisture indicating that onsiderable quantities had been leached be- ow the surface layer of soil. This sugges- ion is substantiated by the data in Table 2 nd the curves in Figure 6.

Since all three plots may be considered as ummerfallow until the potatoes began active rowth we would expect to find the curves for itrates parallel and the curves for moisture parallel. In general this is so; however, the moisture curves for the potato soils are invariably lower than the moisture curve for the summerfallow soil and especially so after the early part of July. The moisture curves for the summerfallow and the cultivated potato soils are much higher than for soils producing non-tilled crops such as barley, wheat, timothy and alfalfa.

The nitrate curves while very similar for the early part of the season do show that where alfalfa had previously been grown nitrate production was stimulated more rapidly than for the summerfallow, and the previous production of timothy had retarded this process below the summerfallow. That the alfalfa residues remaining in the soil have stimulated nitrate production more vigorously than occurred in the soils containing timothy residues is further emphasized by the 1924 curves in Fig. 2.

By comparing the nitrate curve and the moisture curve for the summerfallow plot there seems to be distinct evidence that nitrates are produced in these soils when the moisture content is at least 50 per cent of the dry weight of the soil.

From Oct. 23, 1923 to May 12, 1924, the nitrate content of these plots had increased, especially the plot which had previously grown alfalfa.

Plots 1-K and 1-L which had produced timothy and alfalfa in 1922 and potatoes in 1923 were sown respectively to timothy and alfalfa early in 1924. These crops were about 3 inches high by July 7th after which date the growth was rapid and by Aug. 4th they were 18 inches high. By Sept. 15th, the timothy was about two and one half feet high and fully headed while the alfalfa was about two feet high and in full bloom. Neither of these crops was cut during 1924.

Plot 10-C was sown to wheat varieties early in the year. On June 9th the wheat was up about 5 inches and by July 7th it was about eighteen inches high. By July 21st it was two and one half feet high and Aug. 4th fully headed out. It was beginning to ripen on Aug. 18th and being harvested on Sept. 1st.

The nitrate curves for plots 1-K and 1-L (1924) show a tendency towards accumulation in the early part of the season especially before the crops began to utilize the nitrates. However, after the timothy and alfalfa show-

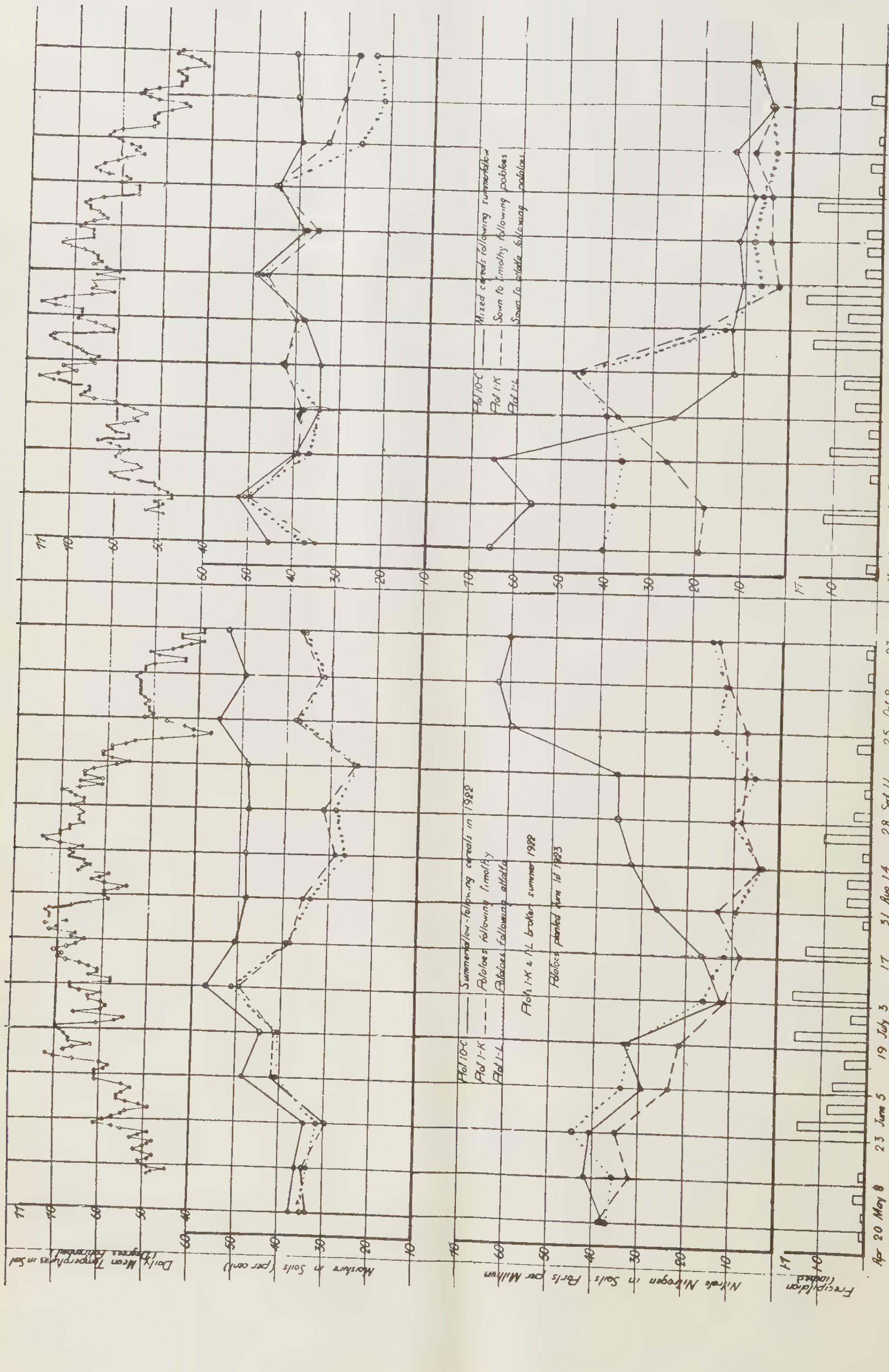

Fig. 2—Nitrate nitrogen and moisture in surface soil under various crops. Left (1923) under summer fallow, potatoes following timothy and potatoes following alfalfa; right (1924) under cereals following summer fallow, timothy following potatoes, and alfalfa following potatoes.

ed rapid growth (about the middle of July) the nitrates were rapidly reduced and kept at a lower level for the remainder of the season than the plot carrying wheat. Moreover the wheat plot contained high contents of nitrate until June 9th, after which the disappearance of nitrates was much more rapid and earlier in the season than for the timothy and alfalfa plots, but it must be remembered that the wheat began making rapid growth and heavy demands upon the nitrates at least a month earlier than the young timothy and alfalfa. The remarkable fact is that the wheat crop could reduce the nitrate nitrogen of the soil from 65 p.p.m. on June 9th, to 12 p.p.m. on July 7th. By referring to Table 2 it will be seen that during the season of 1923 considerable nitrate had accumulated in the lower depths of the summerfallow plot, and by the beginning of 1924 the subsurface and subsoil layers contained respectively 30 and 9 p.p.m. of nitrate nitrogen. There was a tendency for the nitrates of the subsurface to remain high until between July 7th and 21st, and a tendency for the nitrates of the subsoil to increase until July 7th. The rapid reduction of the nitrates began at an earlier date in the surface soil than in the subsurface and subsoil. However, these lower layers of soil contained appreciably greater quantities than did the lower layers of the plot (8-A) growing cereals continuously.

The moisture curves for the soils of these plots are very closely parallel throughout the season. However, during the period of most active growth the wheat soil moisture was reduced below the level of that of the timothy and alfalfa plots, but after the wheat was harvested the moisture content of the soil gradually rose, whereas the growth of timothy and alfalfa continued to reduce the soil moisture of those plots.

Fig. 3 shows the relationship between nitrate nitrogen and moisture in the surface soils under sweet clover following fallow, corn following peas and potatoes following corn for the season of 1923 whereas for 1924 the sweet clover on plot 5-B was pastured and oats were grown on plots 1-5, 1-7, 4-5 and 4-7 following, in the case of the first two plots, corn and in the latter two plots, potatoes.

Plot 5-B was summerfallowed in 1922. In 1923 it was kept well cultivated and free from weeds until the early part of June when it was sown to sweet clover. By July 3rd the sweet clover was just coming through the ground, July 17th it was about 2 inches high. After July 21st the growth was very rapid and as follows: July 31st 5 inches high; Aug. 14th, 12 inches high; Aug. 28th two and one-half feet high; Sept. 11th, three feet; Sept. 25th, three and one-half feet high. After Oct. 8th, but little growth was observed during the remainder of the season.

Plots 1-5 and 1-7 produced peas in 1922 and corn in 1923. Plot 1-5 had never received any fertilizer treatment whereas 1-7 received manure, acid phosphate and potassium sulfate applied to the potato crop in 1920. The corn was sown early in June and was up about 3 inches on June 19th, July 3rd the corn was about one foot high and thereafter made the following growths: July 17th, eighteen inches high; July 31st, three feet high; Aug. 14th, five feet high and beginning to tassel, Aug. 28th, six feet high and ears well formed, about Sept. 8th the corn was harvested for silage and was seven feet high.

Plots 4-5 and 4-7 produced corn in 1922 and potatoes in 1923. Plot 4-5 had never received any fertilizer application whereas 4-7 received manure, acid phosphate and potassium sulfate before the potatoes were planted (1923).

Potatoes were planted in the early part of June. June 19th they were just appearing through the ground, July 3rd, about ten inches high, and by July 17th covered the ground with a rank dense growth of tops. They were fully flowered by July 31st, and by Sept. the tops were dying. Potatoes were dug during the last week in September.

By comparing plots 1-5 and 4-5 respectively with 1-7 and 4-7 (Table 2) it will be seen that at certain dates of sampling the untreated plots, contained less nitrates than did the treated plots, and at other dates the reverse was true. However, as an average for the season the more recent application of fertilizers to plot 4-7 showed an average amount of nitrate nitrogen of approximately 1 p.p.m. more than the unfertilized plot; whereas the same difference occurs in favour of the unfertilized plot when the fertilizers had been applied as early as 1920 to plot 1-7. Since the differences are rather small and in a measure compensating the averages of plots 1-5 and 1-7 and those of 4-5 and 4-7 have been plotted rather than the

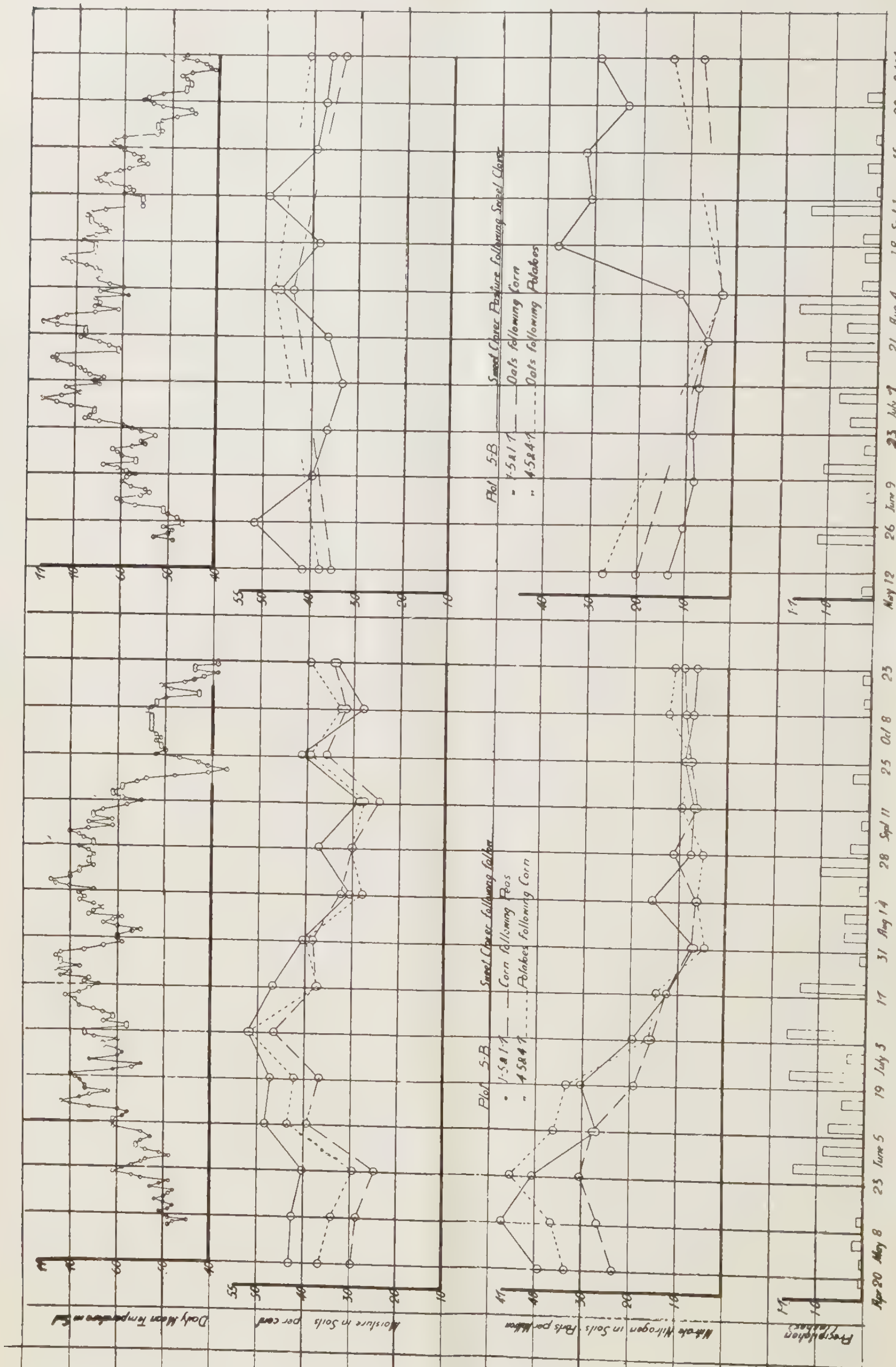

Fig. 3—Nitrate nitrogen and moisture in surface soil under various crops. Left (1923) under sweet clover following fallow, corn following peas and potatoes following corn; right (1924) under sweet clover following sweet clover, oats following corn and oats following peas.

individual nitrate contents for each plot separately.

On April 20th, 1923, the nitrates in all three plots were relatively high and tended to increase for the next four weeks after which they rapidly decreased until about the middle of July when they remained fairly constant until the end of the season. On the first date of sampling the fallowed plot (5-B was cultivated as fallow until the sweet clover was sown in June) contained more nitrates than either the potato or corn soil and likewise the potato plot more than the corn plot.

The nature of the nitrate curves is very similar to those in Fig. 1 for this year except that these soils prepared for intertilled crops show higher nitrate contents from the middle of May to the early part of July than are found under timothy and alfalfa. The moisture curves of the soils under intertilled crops are somewhat higher than under timothy and alfalfa and experience less entreme fluctuation.

From the last sampling (Oct. 23) 1923 to the first sampling May 12th, 1924, all three plots had increased in nitrates. However the sweet clover plot showed less increase than either the corn plots or the potato plots, and at this date contained 13 p.p.m. nitrate nitrogen as against 20 and 27 p.p.m. respectively for the corn and potato plots. During the season of 1924 plot 5-B supported the second year's growth of sweet clover. Active growth had begun by May 26th and on June 9th the new growth was about four inches high. At the next date of sampling the crop was being lightly pastured by sheep. For a short period the sheep kept the sweet clover at a height of about eight inches and then gradually consumed the crop more rapidly than it grew, until about Aug. 1st, when it had become very closely grazed. It was kept closely grazed until Sept. 15th when the sheep were removed. From Sept. 15th to Sept. 29th the crop had grown about three inches. After this date there was but little growth.

Oats occupied plots 1-5, 1-7, 4-5 and 4-7 during the season of 1924. They were seeded May 12th. These plots were sampled at only three dates during the season as indicated by the points on the graph in Fig. 3.

On Aug. 4th the oats were fully headed out and they were harvested about the middle of Sept. at least three weeks before the last sampling.

On May 12th the nitrates were lower in the sweet clover plot than in the others but it must be remembered that the sweet clover had shown some growth during the late part of the 1923 season, after crops had been harvested from the other plots. On Aug. 4th the nitrate nitrogen under the oats as represented by the curves was about 3 p.p.m., whereas under sweet clover the nitrate nitrogen was four times as abundant. However, the sweet clover had been so closely grazed since about Aug. 1st and the absence of crop growth after this date explains the rapid accumulation of nitrates in this plot from Aug. 1st to Aug. 18th. From the nature of this rapid nitrate accumulation during the late summer when sweet clover is pastured it would indicate that some increase in the subsequent crop may be expected, and in this connection it is interesting to note that the wheat crop grown on plot 5-B yielded 57 bushels per acre in 1925.

Fig. 4, shows the relationship between nitrate nitrogen and moisture in the surface soils under corn following summerfallow, and wheat after timothy for the season of 1923, and barley after corn, corn after wheat and fallow after oats for 1924.

Plot 3-A was sown to corn the early part of June and by June 19th was three inches high, July 3rd one foot high and July 17th about eighteen inches. During the next two weeks it attained a height of three feet and thereafter grew steadily, until Sept. 11th, when it was about five feet high and nearly ripe. It was harvested about the latter part of September.

Plot 5-A was broken from timothy in 1922 and remained as timothy sod until about the middle of May 1923, when it was seeded to wheat. Wheat was well up by June 5th and by June 19th was about two and one-half feet high and beginning to head. It was fully headed by July 17th, and by July 31st was half filled and a very heavy crop. It was harvested early in September.

The curves for nitrates and moisture for these two plots are very similar in character and roughly parallel. It is interesting however, to note that during the most active growing period (middle of June to latter part of Aug.) the nitrates and moisture are kept at a lower level under the wheat than under

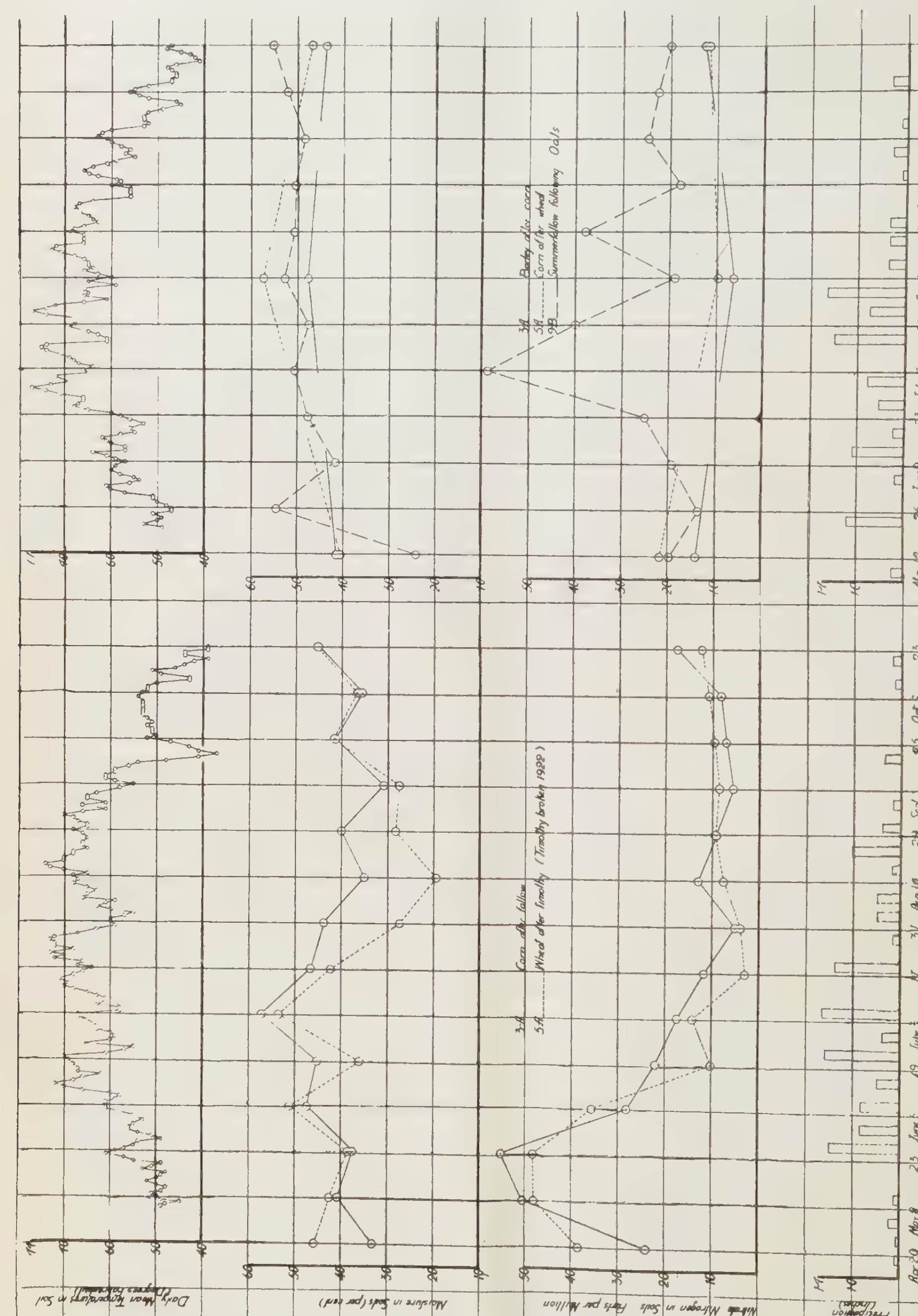

Fig. 4—Nitrate nitrogen and moisture in surface soil under various crops. Left (1923) under corn following fallow and wheat following timothy: right (1924) under barley following corn, corn following wheat and fallow following oats.

the corn. Furthermore the differences between the moisture curves are greater than between the nitrate curves. The wheat reduced the nitrates to a lower level than did the corn and this low level occurred at an earlier date in the season than was the case with the corn crop. Whiting and Schwonover (20) have reported similar results when comparing these two crops grown in the corn belt. They found that the rapid reduction of nitrates under wheat occurred at an earlier date than we found at Edmonton, but this seasonal difference may be accounted for by the fact that they were working with winter wheat whereas our crop was spring wheat.

During the latter part of the season the corn crop reduced the nitrates below the level of those under wheat, but it should be kept in mind that the most active season of growth of corn does not coincide with that of wheat as the wheat reached a maturity about one month earlier than the corn.

At the beginning of 1924 both these plots contained less nitrate nitrogen than they did at the beginning of 1923. This is due to the fact that they had been treated as a fallow in 1922 whereas they had both produced crops in 1923. They were sampled on only three dates in 1924 as indicated by the points on the curves in Fig. 4.

Plot 9-B (summer fallow) shows the rapid accumulation of nitrates in the surface soil during the early part of the summer and then a decrease towards the end of the season. This decrease is partly due to leaching of the nitrates into the lower layers of soil, and will be discussed in connection with Fig. 6.

The production of nitrates in the fallow (9-B) was not as great in 1924 as in the fallow (10-C) in 1923.

In figures 1 to 4 inclusive only the nitrates in the surface soils are plotted and the differences in the total nitrate nitrogen to the depth of 40 inches under different crops and cultivation practices are at times actually greater than the curves in the figures indicate. Not all the plots were sampled to the depth of 40 inches at each sampling date; however, many of them were sampled to this depth at each date especially during the season of 1924. The data from four of these plots are computed from Table 3, and plotted in Fig. 5, as pounds of nitrate nitrogen per acre to the depth of 40 inches. From these curves it will be seen that the total nitrate nitrogen per acre was at times very high especially for plots 10-C and 9-B. The nitrates in 10-C decreased with the advancement of the season due to the demand made by the wheat crop. The fact that they were so high early in the season is due to 9-B being fallowed in 1924 and having produced a crop of oats in 1923. It is interesting to note that the summer fallow plot (9-B) showed a decrease in total nitrates between July 7 and Sept. 1 and then an increase followed by a decrease. A similar decrease, but of greater magnitude is shown to occur in plot 10-C during this same time; however, the wheat crop on 10-C caused a further depression in nitrates until after the middle of September when they again increased to the end of the season.

Stewart and Greaves have observed a similar rapid disappearance of nitrates from the surface of fallow land at times when rain could not leach it downward and they suggest that it may possibly have been changed to protein nitrogen.

The nitrates in plot 5-B carrying sweet clover for the second season, gradually decreased with the growth of the crop until the latter part of July when they rapidly increased during the next month followed by a slight decrease and later an increase. The rapid accumulation of nitrates in this plot during the middle of the summer is due to the fact that the sheep had so closely grazed the sweet clover at this time that there was practically no crop growth to utilize the nitrates.

Plot 8-A, which was producing its third consecutive cereal crop, shows the lowest nitrate curve in Fig. 5; however, during the early part of the season there was a greater tendency for nitrates to accumulate under wheat on this plot than under sweet clover on plot 5-B. This together with the curves in the first four figures indicate the effect of the various crops upon the accumulation of nitrates under them at various times during the active period of their growth.

A further comparison of plots 8-A and 9-B respectively shows the following relationships with respect to the total pounds of nitrate nitrogen per acre; maximum 98 and 222, minimum 32 and 58, average for the season 58 and 132, or in general the maximum, minimum and average amounts of nitrate nitrogen for the season were about twice as great un-

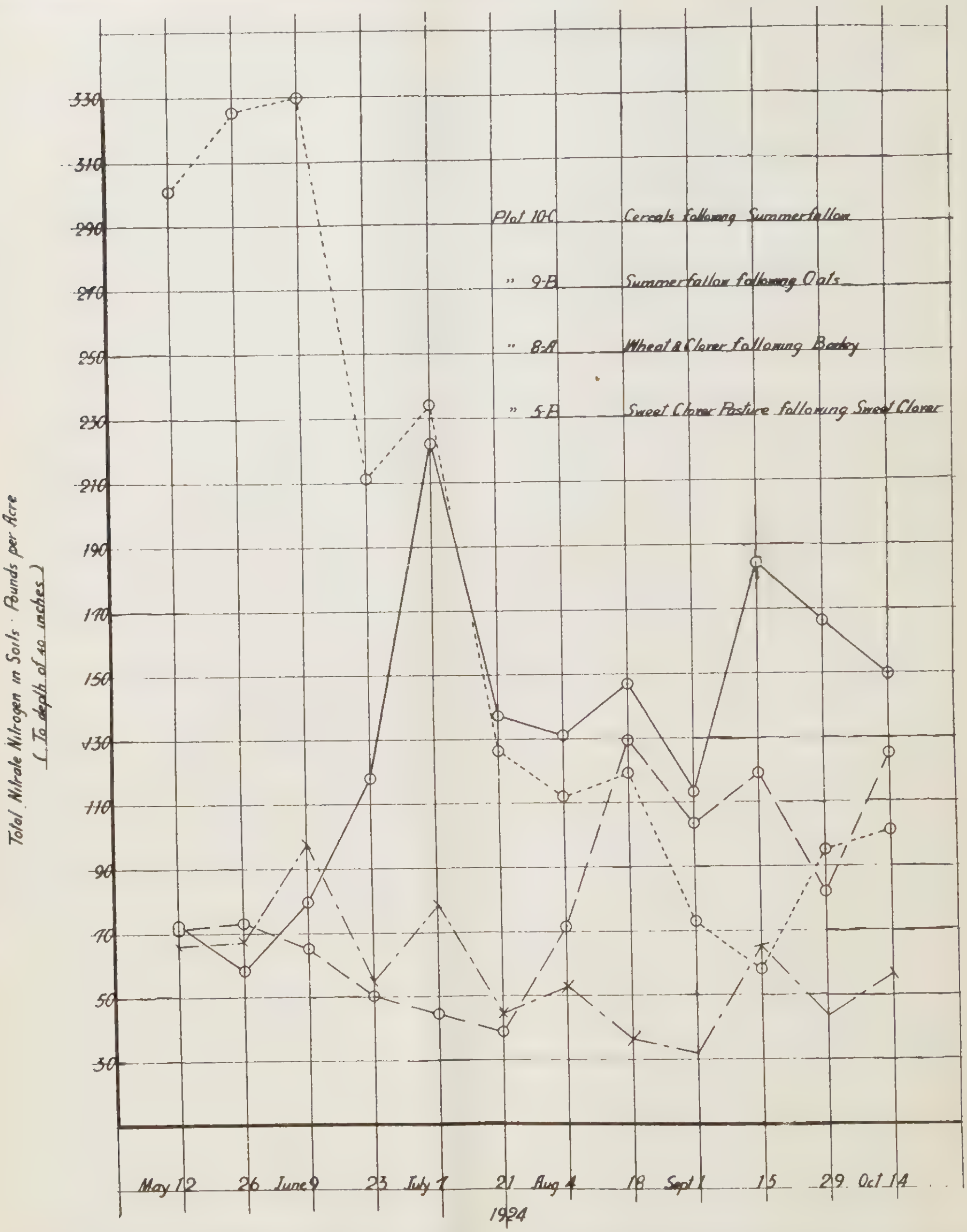

Fig. 5—Total nitrate nitrogen (pounds per acre) in soil to the depth of 40 inches under cereals following fallow, fallow following oats, wheat and clover following barley, and sweet clover pasture following sweet clover (1924).

der summer falow as under wheat, even though at no time during the season did the soil carrying wheat contain less than 32 pounds per acre.

From the curves in figures 1 to 5 it is apparent that there is a decided maximum in the nitrate curves during the earlier part of the season except in the cases where perennial crops are maintaining the nitrates at a relatively low level. This early accumulation of nitrates accompanies increases in soil moisture up to about 50 per cent after which

leaching may disturb this relationship in the surface layer of soil (see Fig. 6). This rise in the nitrate curves likewise accompanies the rise in soil temperature until the decrease in soil moisture due to distribution of rainfall and utilization by crops causes the nitrate curves to follow more closely the moisture curves than the temperature curves.

Again late in the season there is generally a tendency for the nitrate curves and the moisture curves to rise, indicating a second maximum of much smaller magnitude for the season. A similar course for the nitrification process indicating an early season major maximum and a late season minor maximum, has been reported by Russel (14), Whiting (20), Lyon (12), and others under conditions of climate and soil vastly different from ours.

Some of the previous curves especially for plots 10-C in Fig. 2 and 9-B, Fig. 4 seem to indicate that there must be appreciable movements of the nitrates from the surface to the lower layers of soil. This becomes evident if we represent the total amounts of nitrate nitrogen shown in Fig. 5 by plotting it for the various layers of soil for the summer fallow (9-B) and the wheat (8-A) plots. Curves for pounds of nitrate nitrogen per acre and moisture contents of the surface, subsurface, and subsoil of these two plots are shown in Fig. 6.

It should be kept in mind that the data from Table 3, showing p.p.m. nitrate nitrogen have been multiplied by 2, 4 and 6 respectively to obtain pounds per acre for the surface, subsurface, and subsoil layers, and that any experimental error which may have accompanied either sampling or analysis has been mathematically increased three times as great for the subsoil as for the surface. However, despite such possible unavoidable increase or decrease it is quite evident that the nitrates have had a general downward movement during the season under the summer fallow whereas this movement has been much less significant under the wheat crop. Except early in the season the subsurface and subsoil layers of the summer fallow plot contained more nitrate nitrogen than did the surface of the wheat plot. This is to be expected, since under summerfallow the nitrates have a tendency to accumulate in the lower layers of the soil whereas the crop tends to reduce the nitrates in order to meet the demands of growth. There were times when the subsurface layer of the summer fallow plot contained more total nitrates per acre than did the surface layer and on Aug. 4th the per cent in the subsurface was actually greater than in the surface. The curves for nitrate nitrogen in plot 9-B indicate that some nitrate had moved downward beyond the depth to which the soil was sampled and this in part may account for the depression of the total curve as shown in Fig. 5 during the middle to latter part of the summer.

It will be seen that the moisture curves for the subsurface and subsoil layers of plot 9B tended to increase with the advance of the season and the subsurface contained 12 per cent. more whereas the subsoils contained 8 per cent. more on Aug. 4th than they did on May 12th. The moisture content for the subsoil of the wheat plot remained almost constant throughout the season and that of the subsurface showed much less variation than did the corresponding layer of the summer fallow.

Stewart and Greaves (18), have shown that under irrigation there was a downward movement of nitrates to the depth of at least 10 feet whereas spring rains under certain conditions caused a downward movement to the depth of 7 to 8 feet.

Temperature as well as moisture is an extremely important factor in the production of nitrates and it is interesting in this connection to compare the daily soil temperatures with the moisture content of soil for the various plots during the sampling periods of 1923 and 1924. The soil temperature was taken from a strip of bare uncultivated ground on the Campus Field at a depth of 4 inches. Therefore the temperatures recorded will not be absolutely identical with the temperatures of soil under the various crops and fallow; however, the temperature curves will be within at least a few degrees of the actual temperatures of the soil of the various plots.

The mean daily soil temperature is shown in Figures 1 to 4 and the maximum mean and minimum in Fig. 7. It will be seen that there is a distinct relationship between the rainfall and the soil temperature with the fluctuations in temperature lagging after the precipitation columns. There is a very intimate re-

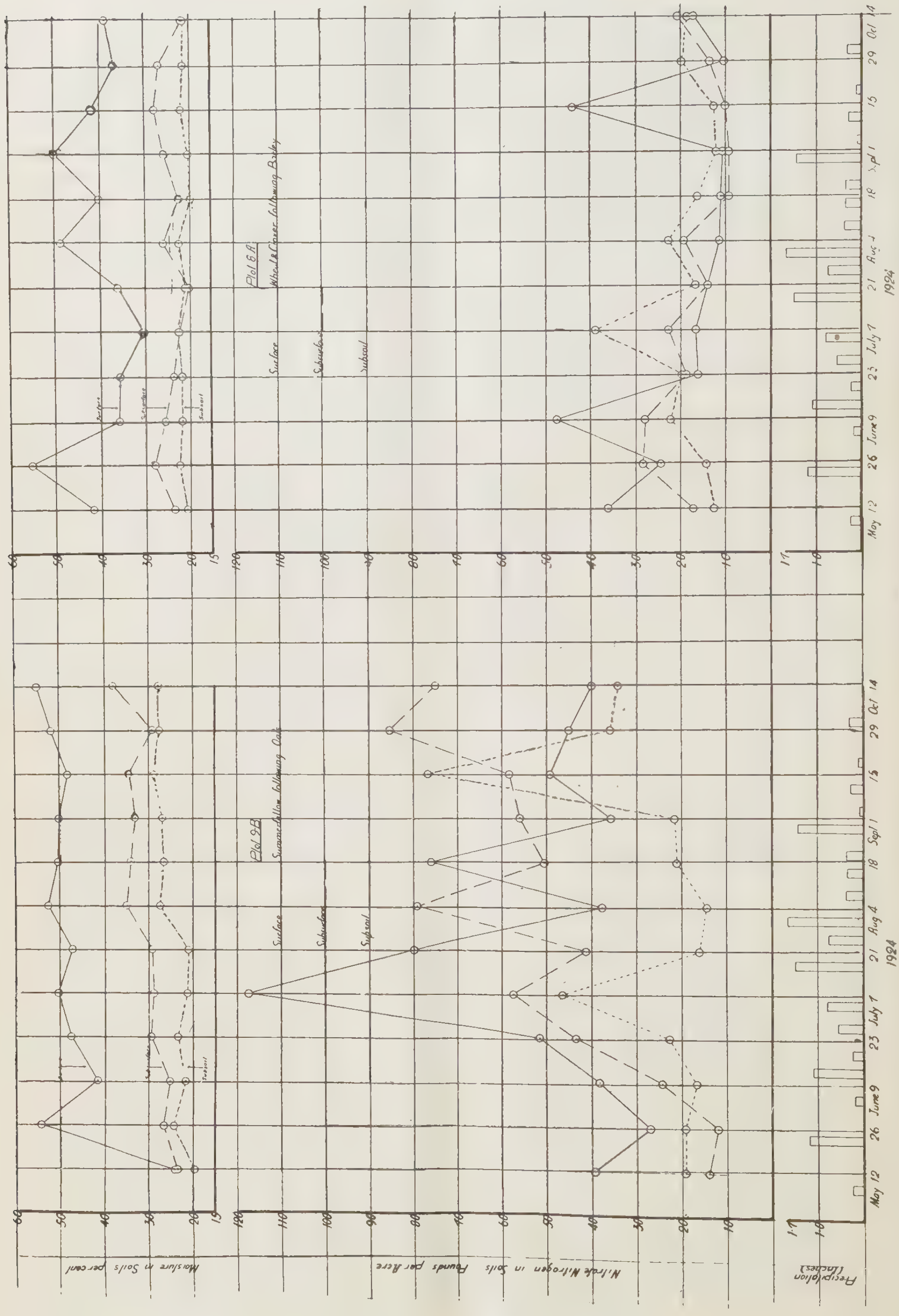

Fig. 6—Distribution of nitrate nitrogen (pounds per acre) and moisture (per cent) in various depths of soil under fallow and wheat (1924).

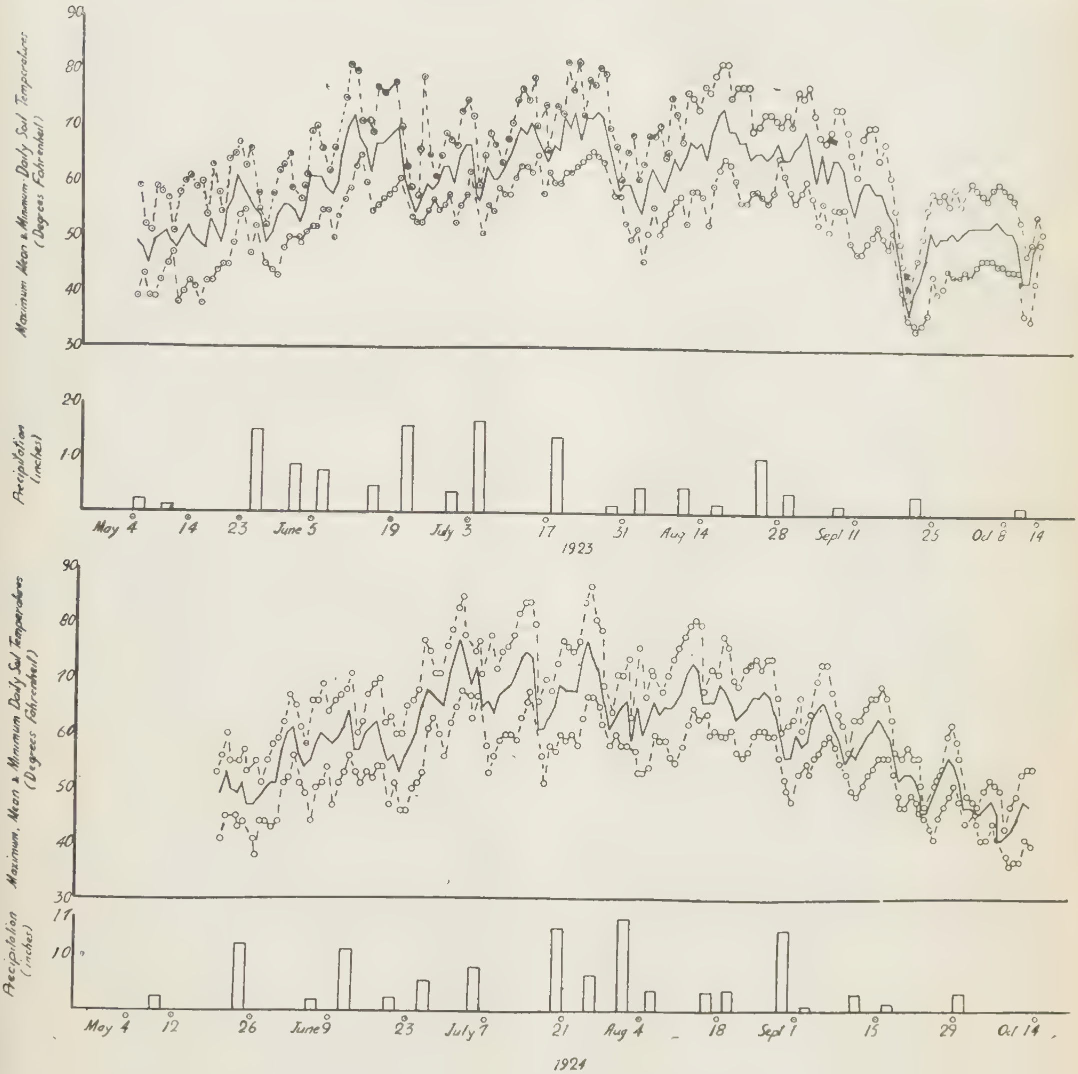

Fig. 7—Maximum, mean and Minimum daily soil temperatures (Farenheit) at Edmonton (1923 and 1924).

lationship between precipitation, soil moisture, crop growth and soil temperature.

Between the latter part of May and the latter part of September the minimum soil temperature was not sufficiently low to inhibit nitrification and at no time during the summer of either season was the maximum temperature sufficiently high to retard this process, materially, even during the warmer part of either of the seasons the mean daily soil temperatures were below the optimum for nitrification as indicated by the laboratory experiments of a number of investigators; however, on the other hand Lipman (10) points out that under field conditions nitrification seems to take place at relatively low temperatures.

SUMMARY

The climate of any region very largely determines the temperature and moisture factors influencing the process of nitrification in soils. It further influences the growth of native-vegetation which in turn governs the nature and amount of organic matter in the soil. This organic matter is used by microörganisms in connection with nitrification.

The climate of the black earth belt of Alberta has been largely responsible for the very fertile condition of the virgin soils as indicated by Table 1. It is characterized by dry cold winters, during which no growth occurs and accompanied by virtually inert soil conditions. The winter is followed by the slow advancement of spring and then the rapid advancement of summer. The summer is characterized by moderately high daily temperatures with long hours of sunshine and generally sufficient moisture to permit of rapid preparation of plant growth. The average annual precipitation at Edmonton, Alberta, for a period of 35 years (1883-1917) is 17.4 inches, 75 per cent. of which falls between Apr. 1 and Sept. 30 and 63 per cent of the total during the 4 months May to Aug. inclusive. The lowest precipitation, 8.16 inches, was in 1889 and the highest, 27.81 inches in 1900.

The soil temperatures from May to Sept. inclusive are never too high to inhibit nitrification, and seldom sufficiently low to retard this process. However, at times the lack of sufficient moisture does materially affect the rate of nitrification.

The soils of this district, as well as those of the prairie belt of Alberta, are well supplied with microörganisms as indicated by laboratory experiments not reported in this paper.

Table 1 shows that the soils of the plots reported in this paper contain an abundance of the mineral plant foods and a comparatively large amount of organic matter (at least 10 per cent. of the surface soil is organic matter).

It is quite apparent that nitrification proceeds relatively rapidly in our virgin soils under field conditions. This fact is emphasized by comparisons with the data obtained by other investigators in various countries having different climatic and soil conditions. For purposes of direct comparison we have constructed Table 4, which shows the average pounds of nitrate nitrogen per acre in the surface soil, under wheat and corn at Urbana, Illinois, corn at Ames, Iowa, and similar crops at Edmonton, Alberta.

From Whiting's data (20) we find that soils under wheat show from 16.01 to 30.41 pounds per acre for the various treatments, as averages for 12 dates of sampling, March 18 to Dec. 18, whereas the soil under corn on these same plots in 1917 showed averages for 12 dates of sampling of from 14.66 to 24.46 pounds per acre. However, when corn was grown on Series 500 (1916) following several years of alfalfa the average nitrate nitrogen for 15 dates of sampling varied from 43.24 to 62.74 pounds per acre.

From Gowda's data (6) the nitrate nitrogen under corn at Ames, Iowa, varied from 16.38 to 31.25 pounds per acre for plots receiving similar treatment to those above referred to at Urbana.

The plots carrying wheat or barley at Edmonton contained nitrate nitrogen varying from 21.6 to 48.8 pounds per acre as an average of 12 or more samplings per season, whereas the soil under corn varied from 30.5 to 39.2 and the summerfallow contained 74.8 pounds in 1923 and 53.0 pounds in 1924.

In general it may be said that nitrification proceeds relatively rapidly under field conditions in the soils of the black earth belt of Alberta. Our figures are higher than those reported by Stewart (18) from Utah, Hall (7) from South Alfrica, Prescott from Egypt, for non-irrigated soils, and most investigators from semi-arid districts. They are about equal to the results obtained by Buckman (3) from Montana. They likewise compare favourably with those of Whiting (18) from Illinois, and Gowda (6) from Iowa. However, on the other hand they are much below those reported by Lyon (12) from New York and Headden (8) from Colorado and in some instances below King's (10) from Wisconsin.

Our results confirm those of other investigators in showing that the production of nitrates in field soils is influenced by the crop growing, the crop sequence, the method of tillage, together with the moisture and temperature factors. The perennial crops such as timothy and alfalfa keep the nitrates at a lower level than do the annual such as wheat, barley, corn and potatoes. The non-tilled annuals such as wheat and barley keep the nitrates slightly lower than the intertilled crops such as corn and potatoes. However in this last respect our differences are smaller than those reported by a member of investigators.

The summer fallow showed much greater accumulations of nitrates than were found under corn or potatoes. This is just opposite to the results of Lyon (12), but similar

TABLE 4

Seasonal averages of nitrate nitrogen in soils under various crops at Illinois, Iowa, and Alberta. (pounds of nitrate nitrogen per acre in surface soil).

Location	Plot No.	Treatment	Wheat 1916 following soy beans series 200	Corn 1917 following wheat series 200	Corn 1916 following alfalfa series 500
Urbana, Illinois	1	None	16.01	16.68	43.24
	2	Residues	19.98	15.30	46.82
	3	Manure	17.40	14.66	43.31
	4	Residues, lime	19.33	15.87	47.62
	6	Residues, lime, phosphorus	20.87	16.24	48.17
	10	Manure X, lime, phosphorus X	30.41	24.46	62.74
Ames, Iowa	Ave. 1300, 1305, 1315, 1335	None		27.02	
	1324	Residues		16.38	
	1301, 1302	Manure		31.25	
	1328, 1331	Residues, lime, phosphorus		22.18	
	1308, 1311	Manure, lime, phosphorus		22.11	
Edmonton Alberta	5-A	None, wheat following timothy	37.2		
	8-A	None, wheat and clover following barley	21.6		
	10-C	None, wheat following fallow	48.8		
	8-A	None, barley following sunflowers	34.2		
	8-A1	None, barley following barley	33.4		
	3-A	None, Corn following fallow		39.2	
	1-5	None, corn following peas		30.5	
	4-5	None, potatoes following corn		39.0	
	10-C	None, summerfallow 1923			fallow 74.8
	9-B	None, summerfallow 1924			43.0

to those of Stewart (18) Hall (7) and others.

The plant residues from legumes promoted nitrification more vigorously and at an earlier date than did residues from non legumes. In this respect our data confirm those of Lyon (13), Whiting (20, 21) and others.

The following figures show the limits of variation of the nitrate nitrogen in p.p.m. in the surface soil for various crops during the growing season: timothy, from a little less than 4 to about 16; alfalfa, from about 4 to 39; potatoes, from about 4 to 50; fallow, from

12 to 63. The above figures are influenced somewhat by the previous crop, and a better idea of the relationship between the influence of the crop and the nitrates in the soil may be had by taking the average nitrate nitrogen for the season. Such a comparison is shown in Table 5.

From Table 5, it will be seen that the seasonal average nitrate nitrogen in the surface soil under the various crops varied from 9.2 for timothy, to 24.4 under wheat following fallow, and that the fallow contained 37.4 and 26.5 p.p.m. respectively for 1923 and 1924. The nitrates under corn and potatoes in general are higher than under wheat or barley, with the lowest nitrates under the perennial crops. By referring to the last column in the table it will be seen that the average seasonal nitrate nitrogen, in pounds per acre to the depth of 40 inches, is greatly increased by the summer fallow. However, on the other hand, it is quite apparent that available nitrogen is not limiting crop production on these soils even though crops are grown continuously.

On plot 5-B the sweet clover was closely pastured and practically no growth occurred during the latter part of the summer; thus the figures for this plot are relatively high. In fact this is the only plot which shows a decided accumulation of nitrates during the middle to latter part of the summer (see Fig. 3). This plot ($1\frac{1}{4}$ acres in area) produced 57 bushels of wheat per acre during the year following the sweet clover pasture.

There is a distinct relationship between the moisture and nitrate contents of the soil, especially during the early part of the summer and until the rapid rate of plant growth disturbs this relationship. In the case of the summer fallow this relationship persists later into the season than when the soil is cropped, and becomes disturbed only when the soil moisture becomes sufficiently great to leach some of the nitrates into the lower layers of the soil. However, in general, the nitrate production shows a slight lag behind the moisture and temperature curves. There is a major maximum in the nitrate production during the later part of spring and the

TABLE 5

Seasonal averages of Nitrate Nitrogen in soil as affected by crop sequence, and cultivation. (nitrate nitrogen p.p.m. in surface soil and pounds per acre to depth of 40 inches).

Plot No.	Crop Sequence	Nitrate nitrogen in surface soil p.p.m.	Nitrate nitrogen pounds per acre to depth or 40 inches
1-A	Alfalfa	11.9	
1-B	Timothy	9.2	
8-A	Barley following sunflowers	17.1	59.9
8-A1	Barley following barley	16.7	
5-A	Wheat following timothy sod	18.6	
10-C	Wheat following fallow	24.4	167.0
8-A	Wheat and clover following barley	10.8	58.4
3-A	Corn following fallow	19.6	
1-5 } 1-7 }	Corn following peas	15.2	
4-5 } 4.7 }	Potatoes following corn	19.5	73.0
9-B	Fallow following oats	26.5	131.8
10-C	Fallow following cereals (varieties)	37.4	206.2
5-B	Sweet clover pasture following sweet clover	18.2	81.6

TABLE 6.

Sums of accumulations and disappearances of nitrate nitrogen under various crops for the season of 1924 (pounds per acre to depth of 40 inches).

Plot No.	Crop	Sum of increases for 2 week intervals	Sum of decreases for 2 week intervals	Balance for season
8-A	Wheat and clover following barley	111.8	121.2	− 9.4
5-B	Sweet clover pasture following sweet clover	155.6	91.8	+ 53.8
9-B	Fallow following oats	350.8	173.8	+177.0
10-C	Wheat following fallow	101.1	302.2	−201.1

early part of summer, and a minor maximum during the early part of the fall. However, when crops are occupying the soil the high point in nitrate accumulation seldom extends into the summer season.

The soil temperatures were largely influenced by the rainfall and air temperatures. In general the soil temperatures are inversely proportional to the soil moisture.

From Fig. 5 it was seen that both the accumulations and disappearances of nitrates from soil, from interval to interval, were relatively high for the summer fallow plots, either during the fallow year or subsequent to it. It was pointed out that some of the nitrates had been leached below the depth of sampling (40 inches) especially in the fallow soil (Fig. 6) but that the nitrates under crops showed very little fluctuation in the lower layers of soil.

The sums of such accumulations and disappearances of nitrate nitrogen from soil for four plots under various crops, as indicated by the nitrate nitrogen content at intervals of 2 weeks, for the season of 1924, are recorded in Table 6. The data in this table show that there is a great accumulation of nitrates in fallow soil (9-B) and a great disappearance when fallowed soil supports a crop (10-C). Furthermore, that the soil (8-A) supporting crops continuously was capable of producing sufficient nitrate nitrogen for the production of maximum crop yields; and that under sweet clover pasture (5-B) the soil not only met the demands of the crop but likewise produced in addition 64 pounds of nitrate nitrogen per acre.

During the process of decomposition of organic matter in soils the production of ammonia precedes that of nitrates, and under our climatic and soil conditions the ammonia nitrogen is almost invariably higher than the nitrate nitrogen; often several times as high. This condition is quite opposite to the results reported by previous investigators. The data for ammonia production in soils at Edmonton, Alberta, will be reported in a subsequent paper.

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STANDARDIZING THE FRENCH CANADIAN HORSE

The French-Canadian breed of horses is particularly suited to the farms of the province of Quebec and in other provinces where a general purpose horse is needed. This breed, however, has lacked that uniformity its promoters have desired. With a view to correcting this matter the Dominion Experimental Farms have established a special farm for the improvement of this breed. The improvement of the French-Canadian horse has been in progress for many years and was commenced co-operatively by the Federal Department of Agriculture, the Quebec Department of Agriculture and the French-Canadian Horse Breeders' Association. The French-Canadian horse farm situated at Saint Joachim in Montmorency county, is in the immediate charge of Dr. G. A. Langelier, Superintendent of the Experimental Station at Cap Rouge, Quebec. At this farm from seventy-five to one hundred head of registered French-Canadian horses are kept. The object is to develop a race of horses weighing about 1200 pounds in working condition, sound, hardy, full of energy, fast walkers, of good appearance and having good dispositions.

The stud was started some years ago with a stock of 38 different strains. These have been reduced to 11 by discarding the families that did not produce as good offspring as themselves. While the colour is not regarded as an essential matter for this breed of horses, about 80 per cent of the stock at this farm are blacks. Breeding operations in this undertaking have been so successful as to have produced upon this farm prize winning stock at the larger exhibitions held in the province. The farm has sold stock not only in the province of Quebec, but also in Nova Scotia, New Brunswick and Ontario.

At St. Joachim a number of fall foals have been reared. Apart from one or two accidental causes these foals developed into very good breeding animals. One of the advantages found from rearing fall colts is that the dam can be worked during all the cropping season. His experience with this work has led Dr. Langelier to issue a warning against over feeding the foals during their first winter as they are liable to get too heavy in body and go wrong in the legs. It is also urged that with the foals being for the most part housed on moist bedding, care should be taken to pare their hoofs to avoid their growing out of shape.

Advances in Animal Nutrition During Past Quarter Century.*

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Although twenty-five years is but a brief span of time in the history of many nations, the past twenty-five years have largely revolutionized our knowledge of animal nutrition and stock feeding.

Indeed, the developments in this field of science have been just as marvelous as the development of the automobile during this same period, the evolution of the aeroplane, or the remarkable discoveries which have given us the radio. However, an important difference lies in the fact that nearly everyone has adopted the automobile as a common means of transportation in this country, and we are all fast adopting the radio. On the other hand, many farmers have failed to adopt the efficient methods of stock feeding which have been made possible by the progress during this past quarter of a century. These men do not realize that it is as absurd to feed their stock in 1900 fashion as it would be to attempt to use today one of the primitive automobiles that frightened horses and pedestrians alike twenty-five years ago.

Balanced Rations in 1900

Even well back in the preceding century, scientists specializing in animal nutrition had appreciated the basic fact, often ignored by farmers, that for efficient and profitable production live stock must secure the *right kind* of raw materials in their food and that these materials, protein in particular, must be supplied in proper proportions.

Since Emil Wolff, the German chemist, brought out his feeding standards in 1864, there was for nearly half a century little advance in the knowledge concerning the nutrients required by the different classes of farm animals. No one yet had appreciated, for example, that a dairy cow needed more nutrients to produce each pound of milk if the milk was high in butter fat, than she required if her milk contained a relatively low percentage of butter fat.

The old Wolff Standards were somewhat modified by Lehmann in 1896, though no very radical changes were made at that time. These standards, which were known as the Wolff-Lehmann Standards, were then used most widely throughout Europe and also the United States in computing rations for live stock until 1915.

One of the most important contributions to the scientific feeding of dairy cows was made by Professor T. L. Haecker at the Minnesota College of Agriculture. In conducting extensive experiments with cows, he found that the requirements for milk production depended not only on the *amount* of milk a cow produced, but also upon the *fat percentage* of the milk. This seems so self-evident to us today, that it is difficult to realize that skilled chemists had previously failed to appreciate this truth.

As the work of the Agricultural Experiment Stations in the United States developed, naturally many investigations were carried on to determine more efficient methods of feeding farm animals. Gradually many data were secured which showed very definitely that the old Wolff-Lehmann feeding standards recommended a much larger amount of protein for certain classes of animals, especially dairy cows and fattening animals, than was actually needed for optimum production. In spite of these more or less isolated observations, most authorities continued to use the old Wolff-Lehmann feeding standards. These were uneconomical, since in most sections of the country protein-rich feeds were more expensive than feeds rich in carbohydrates.

In addition to these feeding experiments conducted by various experiment stations,

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much information of a very great theoretical value was being secured in investigations on the energy value of feeds. These were carried on by such European scientists as Kellner and Fingerling, and especially by the late Dr. Armsby in the United States. The latter conducted extensive investigations with steers by means of the respiration calorimeter at the Pennsylvania Institute of Animal Nutrition.

These researches upon the energy value of feeds showed definitely that the nutrients in roughages, which are high in fiber, have a much lower value than the nutrients in concentrates, due primarily to the fact that more energy is lost in the so-called "work of digestion" in the case of feeds high in fiber.

On account of the immense amount of labor involved in the determination of the energy value of feeds, data of this kind can be secured but slowly. For this reason, in their many years of painstaking work Kellner and Armsby together were able to make determinations on less than thirty individual feeds or concentrate mixtures. While these values are helpful in estimating the probable net energy values of other feeds not yet tested, such computed results are but approximations.

Moreover, these results were secured chiefly with steers and later investigations have shown rather widely differing values for other classes of animals. For these reasons, in the opinion of the writer, it is still just as wise to compute balanced rations upon a basis of "digestible nutrients" as to compute them in terms of "net energy".

It has been previously mentioned that the Agricultural Experiment Stations had gradually accumulated much evidence showing that the old Wolff-Lehmann Standards were not economical as applied to the usual American conditions. Appreciating this fact the writer attempted in 1915 to combine in a set of standards what appeared in his judgment to be the best guide available at that time in the formulation of rations for various classes of animals. The recommendations gathered together in these standards were taken from many sources. For the reasons stated previously, the standards were expressed, not in terms of net energy, but in terms of *digestible crude protein* and *total digestible nutrients.*

These standards were formulated, not with the idea that any set of feeding standards can be taken as hard and fast guides to live stock feeding, but as approximations which might prove useful to those desiring to compute economical balanced rations for farm animals.

How Far Can Feeding Standards Be Followed?

Feeding standards give no recommendations with reference to several exceedingly important factors of nutrition discovered during recent years. These are the quality, or kind of protein, the amount and kind of mineral matter, or the amounts of the different vitamins which are needed by the various classes of live stock. Our knowledge of all of these recent factors in nutrition is yet too fragmentary to express in the terms of a feeding standard. Indeed, it is doubtful whether certain of these nutritional factors can ever be taken into consideration in any future feeding standards.

In the light of our present knowledge, we realize that these other factors are just as important in a successful ration as the amount and proportion of protein. On the other hand, the discovery of these newer factors does not mean that we can disregard or minimize the fact long known, *that a certain amount of digestible crude protein must be supplied* in a ration if efficient results are to be secured.

Quality of Protein is as Important as Amount of Protein

One of the most important advances in our knowledge during the past quarter of a century has been the discovery of the importance of the kind or quality of protein in stock feeding. It is now well known that proteins are exceedingly complex nitrogenous compounds, made up of 18 to 20 different molecules. The complexity of proteins is shown by the fact that chemists estimated that each molecule of the various plant and animal proteins contains from 2,000 to 100,000 atoms.

Scientists have discovered that some proteins contain all of the different kinds of amino acids, while others are incomplete and do not contain certain of these "building stones". They have furthermore found that animals need for growth, and even life itself, all of these different amino acids. Further-

more, they can not manufacture in their bodies any missing amino acids from other amino acids in their food with the exception of certain of the simpler ones. Therefore, they must receive in their feed an ample supply of all of the "essential" amino acids, or growth will be checked, production lowered, or even health destroyed.

Extensive investigations by Osborne and Mendel and others have shown that the chief proteins of all of the cereal grains are of the same general kind or composition. For example, zein, the chief protein of corn, entirely lacks certain of the essential amino acids.

On account of this, the protein mixture supplied by any single grain or any combination of grains is too low in some of the essential amino acids, which an animal needs to build its body tissue, or which a cow needs to produce milk. On the other hand, investigations show that milk protein contains all the amino acids in good proportion for the use of animals.

At the present time much careful work is being done in various laboratories to study the nutritive value of the proteins in different feeds. These investigations will, without question, throw much light on more efficient ways of compounding rations for live stock.

As an example of such investigations, experiments carried on by McCollum, Hart, and Steenbock at the Wisconsin Experiment Station may be cited. When young pigs in nutrition experiments were fed only corn, wheat, or oats, as the only source of protein, they retain in their bodies for growth only 23 to 28 per cent of the protein in their feeds. Though linseed meal when properly used is a most excellent stock feed, when this feed was used as the only source of protein in a ration, it was found that the protein was of even poorer quality than that of corn, only 17 per cent being stored.

On the other hand, with skim milk 66 per cent of the protein in the milk was stored by the pigs. Purified milk casein was nearly as efficient, 51 per cent being retained.

Many people believe that a variety will of itself meet any deficiencies. This is an unsafe conclusion, for it was found that a mixture of one-third each of corn, wheat, and oats was only a trifle better than any one of the cereals alone. On the other hand, when a mixture of three-fourths corn and one-fourth linseed meal was fed, much better results were secured than with either corn or linseed meal alone, 37 per cent of the protein being stored. stored.

Of all of the feeds tested, skim milk was the most efficient supplement to the cereals. Pigs fed 1.3 lbs. of skim milk with each pound of corn stored about 62 per cent of the protein in their feeds. Corn and tankage and barley and tankage also were efficient combinations, though ranking somewhat below corn and milk.

Of proteins from plant sources, investigations have shown that the proteins of soybeans and peanuts rank high. These feeds are well suited to serve as supplements to the cereal grains, so far as quality of protein is concerned.

Practical feeding experiments conducted with the various classes of farm animals have shown clearly that the quality of protein is usually of much more importance in feeding growing, fattening pigs and poultry than it is with other classes of stock. This is due to the fact that cattle, sheep, and horses consume a much larger proportion of roughage than do pigs or poultry. The quality of protein in roughage, especially in legume hay, is much better than that in the cereals. Consequently, when these classes of animals are fed legume hay as a considerable part of their roughage allowance, there is not so much difference in the efficiency of the protein supplied by various protein-rich supplements, as there is with pigs and poultry.

Protein from animal sources has an especially high value for swine and poultry due to these very reasons. In view of the limited supply of feeds of animal origin, it is fortunate indeed that for other classes of animals highly efficient rations may readily be made up without including any such feeds.

Mineral Matter Indispensable in Rations

Twenty-five years ago little attention was paid to the mineral content of rations fed live stock. It was recognized that stock should receive common salt (sodium chloride) in addition to the amount contained in the usual feeds they were fed. Since that time there has been a remarkable development with re-

ference to our knowledge of the mineral requirements of live stock.

We now know that it is just as essential that rations contain an adequate amount of various mineral nutrients as it is that they supply plenty of protein. Fortunately, dame nature has provided for humans and live stock as well quite adequateely with reference to mineral matter. The foods we eat and the feeding stuff we furnish live stock contain all the necessary mineral compounds, at least in small amounts. Moreover, the body is able to use many of the mineral compounds over and over, taking them back again into circulation after having been once used.

Calcium and Phosphorus May be Lacking

Since over 90 per cent of the mineral matter of the skeleton consists of calcium (lime) and phosphorus, these mineral compounds are most apt to be lacking in usual rations fed live stock, in addition to common salt. A lack of these two minerals is especially apt to occur in the case of young growing animals, which need an abundance for developing their skeleton, and for dairy cows, which are using a large amount of calcium and phosphorus in making milk.

It would be impossible to discuss, in the confines of this paper, the large amount of important work which has been done in recent years on the mineral requirements of live stock. As an example of the importance of these investigations in practical live stock feeding, experiments which have been carried on continuously since 1908 by Professor Hart and his colleagues at the Wisconsin Experiment Station with growing heifers and dairy cows, may be mentioned.

In these trials it has been found that when cows are fed straw for roughage along with grain and grain by-products, they usually produce dead or weak calves. Young heifers raised on such rations even fail to grow normally, and in some cases suffer from nervous breakdowns.

For a few years the nutritional experts were at a complete loss to understand the reason for these astonishing results. However, it has been found that the disasters are due to a lack of lime or calcium in the ration. When calcium has been added in such forms as calcium phosphate (the chief mineral constituent in bones) or even by adding wood ashes, much better results are secured.

However, when alfalfa or clover hay are substituted for half the straw in these rations, even better results are obtained, and entirely normal offspring are produced.

There is, however, absolutely no proof that any mineral mixture will prevent or cure the contagious form of abortion. This is caused by specific germs, and is different from abortion caused by lack of lime in the feed.

Numerous experiments at various stations have shown the importance of supplying plenty of calcium in the rations of swine. For example, rations such as corn and soy beans or corn and peanuts are radically improved by adding a calcium supplement. On the other hand, when the feeds which make up the ration already supply a fairly liberal amount of calcium, there may be little or no benefit from adding any mineral supplement to the ration except common salt. Much scientific work shows that calcium supplements are highly important in poultry feeding.

When farm animals are fed properly balanced rations containing ample protein, there is less apt to be a deficiency of phosphorous than of calcium. This is because most protein-rich feeds are high not only in protein but also in phosphorus. Such is especially the case with wheat bran, wheat middlings, linseed meal and cottonseed meal.

Mineral Requirements for Milk Production

It has long been known that milk is rich in mineral matter especially in calcium and phosphorus. However, up to a few years ago it was assumed that when dairy cows were fed common, well-balanced rations containing plenty of protein and a liberal amount of legume hay, there could be no deficiency in either calcium or in phosphorus, for legume hay is rich in calcium, and protein-rich feeds are in general high in phosphorus.

Surprising results were, however, secured in extensive experiments at the Ohio Experiment Station by Doctor Forbes. In these trials high-producing cows have been fed such excellent winter rations as alfalfa or clover hay and corn silage for roughage, along with corn and such high protein concentrates in addition as wheat bran, cottonseed meal, lin-

seed meal, dried distillers' grain, or gluten feed.

On these rations, which have always been considered ideal for dairy cows, in most instances the animals lost calcium, phosphorus, and also magnesium from their bodies, in spite of the fact that the feed they were given supplied what would appear to be ample amounts. For some reason or other, the cows were unable to assimilate and retain enough of the liberal supply of these mineral nutrients in their feed to meet the heavy requirements in producing the large amount of milk they yielded.

Even when abundant amounts of calcium, or both calcium and phosphorus, were added to their ration in such forms as steamed bone meal, calcium carbonate, or calcium lactate (a soluble form of calcium), the losses of these mineral constituents from the body continued. The reason for this little-expected condition is still a problem. Possibly the milk-producing capacity of our dairy cows has been so increased by selective breeding that it exceeds the ability of high-yielding cows to assimilate sufficient mineral nutrients from their feed to meet the heavy demand in producing the large flow of milk during the first part of the lactation period. Later on in lactation, or when they are dry, they undoubtedly are able to build up again the stores of these mineral constituents in their bodies.

In recent experiments at the Wisconsin Experiment Station by Professor Hart and his colleagues, it has been found that cows are able to assimilate calcium much more completely from fresh green feed than from dried forage. Also, well-cured alfalfa hay was superior to that exposed to sunlight. These trials indicate that fresh green forage and well-cured dried hay contain larger amounts of the vitamin discussed later, which aids in assimilating lime from the food.

All this work on the mineral requirements of dairy cattle is so recent that we do not yet know just how far-reaching the results may be in practical feeding. These various trials, however, emphasize the importance of pasture and other green forage for dairy cows during the growing season, and of furnishing an abundance of legume hay during the rest of the year. Also, the cows should be dried off six to eight weeks before freshening, and during this time should be so fed that they will be in good condition at calving. This rest period will give them an opportunity to rebuild the stores of calcium and phosphorus in their bodies, which may have been depleted by the drain of milk production.

If poor roughage must be fed to dairy cows, such as hay from the grasses (not legume), corn stover grown on acid soil, or straw, there should be added to each 100 lbs. of the concentrate or grain mixture 3 to 4 lbs. of ground limestone, wood ashes, or dried marl. Ordinary dolomitic limestone may be used satisfactorily.

If there is not 20 per cent of high-phosphorus feeds in the concentrate mixture (such as wheat bran, wheat middlings, linseed meal or cottonseed meal), it is best to use 3 to 4 pounds of steamed bone meal, or bone black with each 100 lbs. of the concentrate mixture, instead of using the limestone, wood ashes, or marl. Bone meal and the bone black supply both calcium and phosphorus, while limestone, wood ashes and marl furnish calcium but practically no phosphorus.

If plenty of alfalfa, clover, soybean or other legume hay is fed, then there may possibly be no advantage in adding a calcium-rich mineral supplement to the ration. However, even with legume hay available for winter feeding, it can do no harm and may do considerable good to add one of these lime carriers to the ration. A high-producing dairy cow is entitled to the benefit of any doubt; therefore, it is wise to be sure that she is supplied with plenty of calcium and phosphorus.

Iodine Sometimes Necessary

Especially in certain sections of the northwestern states, during recent years heavy losses have been experienced of new-born pigs, lambs, kids, calves, and foals, due to goitre or "hairlessness". The young so affected are born dead or weak, are frequently hairless, and commonly have enlarged necks. This is due to the thyroid gland in the neck being diseased and enlarged, just as in the case of humans suffering from goitre, brought about probably by a lack of iodine in the feed or a failure to absorb and use the traces of iodine usually present in the feed. Recent investigations have shown that this trouble with the offspring can be overcome by ad-

ministering iodine in the form of potassium or sodium iodine to the pregnant dams.

Vitamins are Necessary for Life

A few years ago the word "vitamins" was unknown, but now nearly everyone has heard of these mysterious substances. Perhaps to many persons the statements made concerning the marvelous effect of these compounds on the human diet likewise in stock feeding have appeared highly improbable and they have wondered "just how much does all this talk about vitamins amount to anyway? Is there any need of giving any consideration to them in planning the diet of my family or in feeding live stock?"

Practically all the discoveries about vitamins have been made in little more than a decade. Although our knowledge concerning them is far from complete today, yet brilliant progress has been made during the past few years by the scientists studying these matters. Therefore, many conclusions may now be safely drawn concerning the importance of vitamins in the feeding of humans and in the feeding of farm animals as well.

Thus far four vitamins have been discovered, and possibly a fifth. The history of the development of the present day knowledge regarding vitamins is exceedingly interesting but can not be discussed here. All that can be attempted is to give a few conclusions regarding the importance of each vitamin in stock feeding.

Vitamin A

The first vitamin to consider is Vitamin A, a fat-soluble vitamin. Absence of this vitamin in the ration of young animals will check growth, produce blindness, produce respiratory diseases, and eventually cause death.

From the standpoint of human nutrition the most important facts regarding this vitamin are that it is contained in liberal amounts by butter fat, the yolks of eggs and salad greens.

From the standpoint of stock feeding the most important facts are that Vitamin A is contained in abundance in all green plants and also in green-colored, well-cured hay. Also, yellow corn is rich in it, while white corn and most other cereals contain little. From these statements it is evident that stock which are on pasture or which have plenty of good hay will not suffer from a lack of this vitamin.

Vitamin B

Years ago thousands of Oriental people living chiefly on polished rice suffered from a nervous disease called beri-beri. Investigations have shown that this disease is caused by the lack of Vitamin B, a water-soluble vitamin, and can be readily cured by supplying foods rich in this dietary essential.

From the standpoint of live stock feeding it is important to realize that all ordinary stock feeds are rich in this vitamin. Hence, there is no evidence that farm animals usually suffer from any deficiency.

Vitamin C

This vitamin prevents scurvy, a serious disease affecting humans when they can get no fresh food. Vitamin C is of even less importance than vitamni B in stock feeding, for man, monkeys, and guinea pigs are the only animals known to be affected with scurvy.

Farm animals either do not require any of this vitamin or else they need only such extremely small amounts that they always get enough in their rations. At least there is no definite proof that farm animals ever have scurvy.

Vitamin D

From the standpoint of stock feeding the fourth vitamin is very important. This vitamin, which prevents the disease called rickets, is known as vitamin "D", or the anti-rachitic vitamin. This disease of rickets seriously affects the bones, especially of young animals. In young animals suffering from the disease, the calcium and phosphorus are not deposited properly at the ends of the bones, where the growth occurs.

Rickets may be caused by a lack of calcium or phosphorus in the food, or by a failure of the body to assimilate these minerals. Even when an animal is supplied plenty of calcium and phosphorus, it is apparently unable to use it for bone formation unless there is plenty of the anti-rachitic vitamin in its food.

Sunlight also has an important relationship to rickets. Animals in darkness or out of direct sunlight are more susceptible to rickets than those exposed to sunlight. Sunlight will even cure rickets, if not too far advanced. The rays in sunlight which have this anti-rachitic property are the ultra-violet

rays; i.e., the invisible rays of even shorter wave length than the violet rays.

Many investigators are studying the effect of ultra-violet light and sunlight upon animals under various conditions and exceedingly interesting results are being secured. It has even been found by Dr. Steenbock at Wisconsin and later by Dr. Hess in New York that ultra-violet light will confer on certain foods the anti-rachitic property. Just what will be the practical significance of all these investigations it is yet too early to predict.

Under winter conditions in the northern states, young pigs are especially subject to rickets. They become lame and stiff, particularly in their hind legs, and farmers call the trouble "rheumatism" or "paralysis." This condition can usually be prevented by including a small percentage (about 5%) of good green-colored alfalfa hay in the ration, and providing plenty of calcium. Apparently dairy cows may also suffer from a lack of the anti-rachitic vitamin under winter conditions, as has been pointed out previously.

Vitamin X

Still a fifth vitamin has been discovered recently by Dr. Evans of California. This has not been named as yet, but is called merely Vitamin "X". This is concerned with reproduction. It has been found that animals which do not receive the vitamin in their food do not reproduce. Little is yet known concerning this vitamin and its occurrence in various foods. Apparently, however, it is present in most ordinary stock rations.

Importance of Efficient Rations

In conclusion, let us consider what these discoveries of the past quarter century mean in terms of practical stock feeding.

For the farmer, these recent developments emphasize anew the importance of providing an abundance of legume hay for his stock. Well-cured alfalfa or other legume hay has all the following merits. Legume hay is rich in proteins. The proteins are of the right kind or quality to supplement the deficiencies of the cereal grains. It is rich in calcium, the mineral constituent in addition to common salt which is most apt to be lacking in usual rations. It is a good source of vitamins A and D, which are the only vitamins apt to be lacking in the rations fed live stock.

There are, therefore, all these important reasons, in addition to the large yield per acre and the improvement of soil fertility for growing plenty of legume hay on every stock farm.

For the feed manufacturer, these recent discoveries are also of profound significance. He can best serve the interests of his patrons only when he appreciates these new developments in nutrition and when he also fully understands the common feeding methods and practices of his patrons. Only then is he able to develop the most efficient formulae for his feeds—formulae so designed that his mixed feeds, used in combination with the common home-grown feeds of his district, will make the most efficient rations for his patrons.

Cyclical Movements in the Live Stock Industry.*

TAGE U. H. ELLINGER

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In recent years, considerable attention has been paid to the apparent regularity with which certain phenomena in the live stock business occur. The facts have been described by Henry A. Wallace, Warren and Pearson, and in publications from the United States Department of Agriculture and Armour's Live Stock Bureau. The evil effects on the industry caused by a pronounced lack of stability are fully appreciated. It is, moreover, realized that the responsibility for the existing conditions rests with the producers collectively, since the majority of them react to immediate business conditions in the same general manner. Temporary depression causes liquidation on a scale not warranted in face of an approaching period of scarce supply and high prices. On the other hand, when this latter condition develops, it induces such expansion in the breeding program that the favorable market conditions it was supposed to utilize are destroyed. Actions of this nature may be noted in all kinds of business activity and are by no means limited to agricultural production. They seem to be based on characteristic traits in human nature. As long as this condition exists, however, it furnishes a basis for profitable operation by the informed and shrewd who see an advantage in operating against the current, being in business when the majority is out and vice versa.

Live stock men are becoming increasingly aware of the fact that studies concerning secular and cyclical trends in the production and value of live stock are helpful in planning future operations. There is in such statistical presentations, however, no magic that will enable the student accurately to foresee future happenings; rather do such data embody in easily understandable form the practical experience of the industry over a period of years for which the memory of the single individual does not suffice. The safest way of planning for the future is probably on the basis of long-time personal experience. Not all live stock men are equipped with such experience, nor are they always in a position to interpret the trend of market conditions satisfactorily. This study attempts to show in figures and illustrations what has been the general experience of farmers in regard to the production and value of live stock.

Receipt figures at the Union Stock Yards of Chicago have been selected as an indicator of volume of production. Data are available back to the opening of the Chicago yards in 1865 and are recorded in the Daily Drovers Journal Yearbook of Figures. The data on live stock values have been obtained from Warren and Pearson's book 'The Agricultural Situation'. Their material is based on the United States Department of Agriculture estimates of prices paid to producers for the various agricultural commodities.

In order to make the two sets of data, for volume and value, directly comparable, both have been expressed in index numbers using the five years 1910 to 1914 as the base equaling 100. In other words the receipts and prices for a certain month are divided by the corresponding average receipts and prices for the five years preceding the war to obtain the index numbers for that particular month. Due to the fact that during the period covered, the value of money (gold) and the price level have undergone violent fluctuations, it has been deemed expedient, in order to bring out the points under discussion, to express values in terms of purchasing power instead of in terms of money. This is done by dividing the monthly live stock price indexes by the corresponding all commodity price indexes as published by the United States Department of Labor and adjusted to the 1910 to 1914 base.

Hog Cycles

The receipts and value curves for hogs (Figure 1) indicate a slow upward moving trend, but especially conspicuous are the fairly regularly occurring deviations up or down from the general level.

The length of the cycles from peak to peak or from trough to trough is four to five years. In the seventies and eighties it was slightly longer, the turnover in the business being

* A lecture delivered at the Sixth Annual Convention of the C.S.T.A., June, 1926.

slower in early days. The receipts and value curves move in opposite directions in conformance with the well established rule that an increase in the volume offered for sale depresses the price, while a reduction in supply has the opposite effect.

The revenue obtained from the sale of hogs is primarily applied for two purposes—paying the cost of production and from what is left over, purchasing the many necessities and conveniences of modern life. The price of corn, moreover, is the most important item in the cost of raising hogs. Besides the purchasing power of hogs in terms of all commodities, it is therefore necessary to study their purchasing power in terms of corn. An estimate of corn prices paid to producers is published monthly by the Department of Agriculture and these data are used for the following compilation: An index number of corn prices is computed on the 1910-1924 base; the hog price index for each month is then divided by the corn price index for the same month to secure the index for the purchasing power of hogs in terms of corn.

Hog values in terms of all commodities and in terms of corn are illustrated in Figure 2. The cyclical movement of hog values in terms of all commodities is quite pronounced. The solid line runs high in 1910, low in 1911 and 1912, high in 1913 and 1914, low in 1915, 1916, and the beginning of 1917, high in the rest of 1917, 1918 and the beginning of 1919, low in the rest of 1919 and 1920. In 1921 and 1922, considerable irregularity occurred in prices at a time when the hog business was due for a peak. Two exceptionally large corn crops, resulting in unusually low corn prices, however, produced a favorable condition by lowering the cost of production so that a substantial profit was secured even at relatively low hog prices. This condition existed in 1921 and 1922. Another trough in the business covered 1923 and 1924. At the end of this latter year, however, both curves started to mount and continued to do so during the first month of 1925 until a new high level was reached which has been maintained since.

Cattle Cycles

The cyclical movements in the cattle business are more clearly defined than in any other branch of the live stock industry as illustrated in Figure 3.

The first two decades in the history of the Chicago market constituted a growth period during which the present organization of cattle production and marketing was established. Receipts increased regularly and cattle values were relatively stable in the face of a rapidly growing demand for beef. For the last forty years a condition of equilibrium seems to have been reached at a balancing point not differing much from the 100-level. Receipts, as well as values, have for this period of time fluctuated with great regularity above and below this base line. The distances from peak to peak or from trough to trough in both curves have been regularly from fourteen to seventeen years. It is very apparent that the relationship of the two curves is inverse and also that, on a percentage basis, the magni-

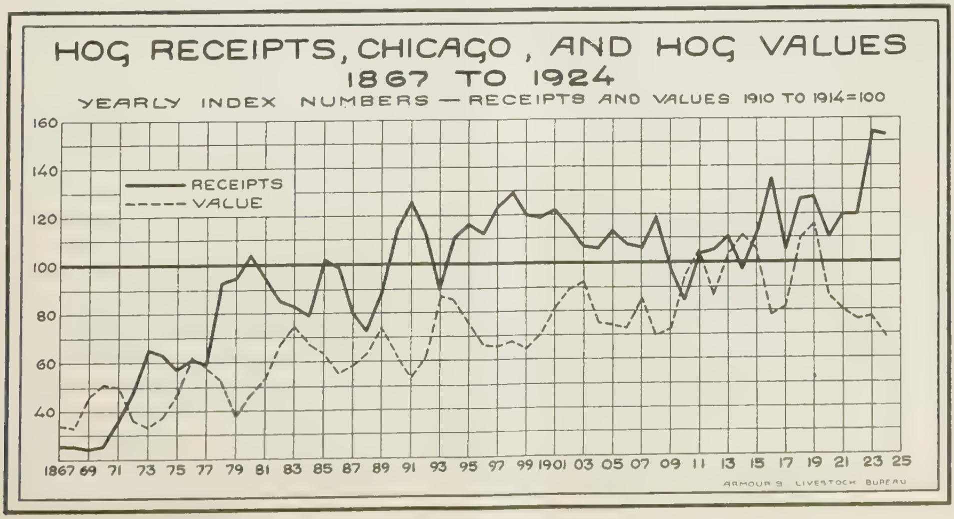

Fig. 1

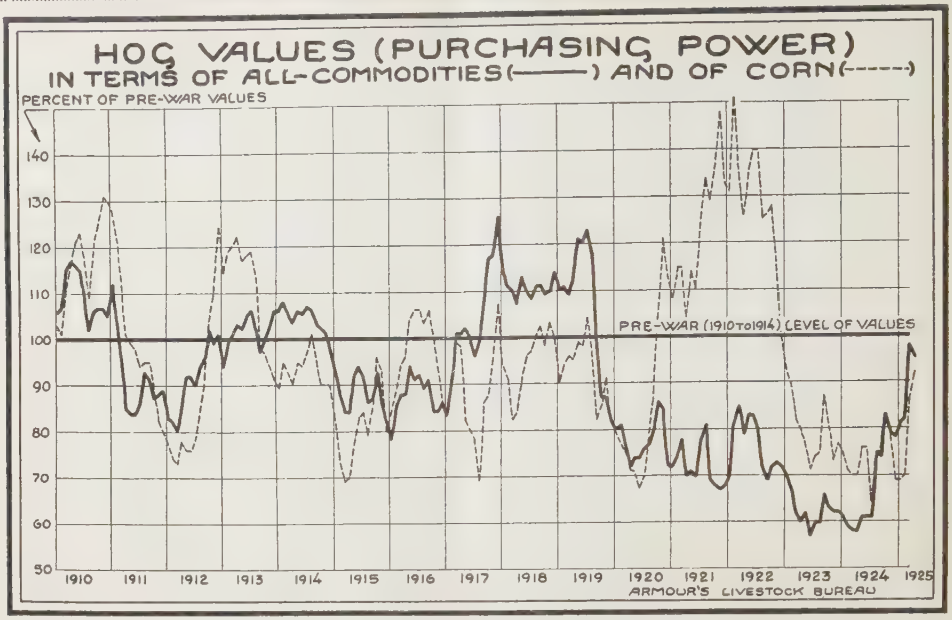

Fig. 2

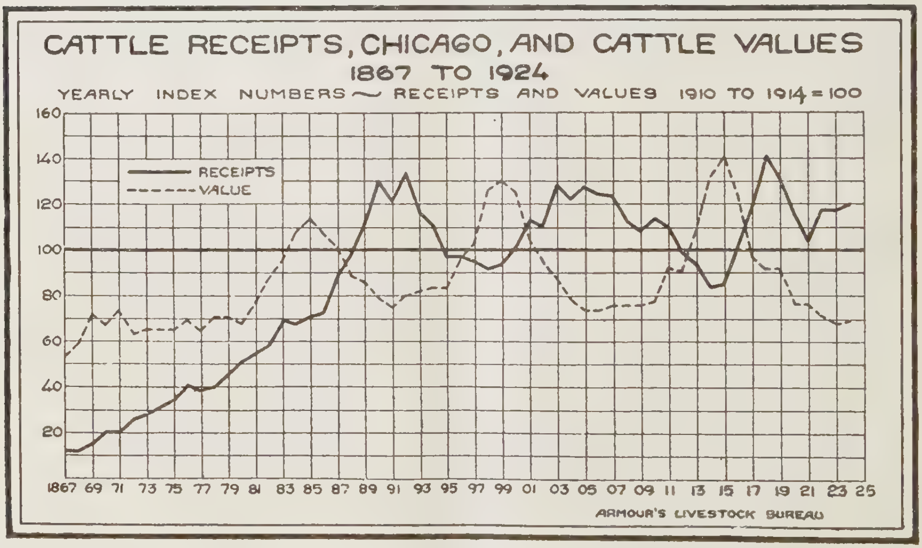

Fig. 3

tudes of the fluctuations in opposite directions are approximately equal.

It seems reasonable to conclude that the last few years have constituted the bottom of a severe depression and that a long time swing towards more remunerative price conditions may be expected. A significant fact reveals itself when the various quality grades of cattle are studied separately. Selecting 1200 to 1500 pound steers, fat cows and heifers, and canners and cutters as three representative grades, the steers as well as the cutters and canners reached their lowest price level in 1921, while the fat cows and heifers struck the low point the year before. Since then the steers have improved their position from 69 per cent of pre-war value in 1921 to 83 per cent in the first seven months of 1925, included in this study, or a rise of 14 points. Fat cows and heifers improved from 63 per cent in 1920 to 74 per cent in 1925 or 11 points; while canners and cutters selling at 53 per cent of pre-war values in 1921 had only improved their position 3 points to 56 per cent

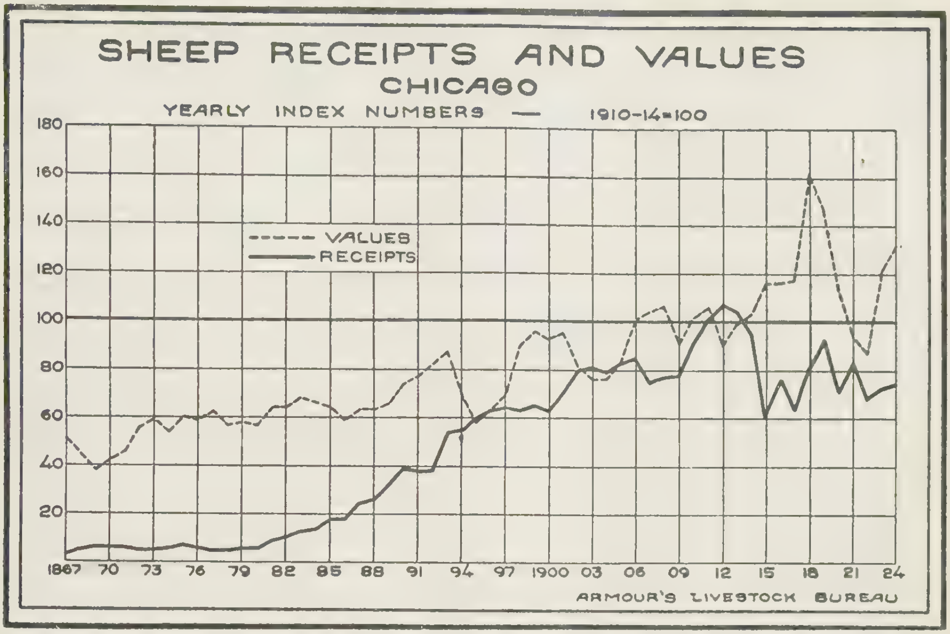

Fig. 4

in the first seven months of last year. The different development displayed by the three grades of cattle shows that the low grade animals constitute a severe drag on the cattle market. The poorly bred animals as well as the unfinished stock are the ones that have not found a market ready to absorb them at improving price quotations. The cattle market has paid an increasing reward for quality, a situation that should encourage breeders and feeders to combine their best efforts to produce a superior product. The data presented definitely refutes the assertion that the market does not recognize such effort.

Sheep Cycles

A similar periodicity to the one described for hogs and cattle occurs in the sheep industry, although the ups and downs in the sheep business do not display the pronounced regularity existing in the swine and cattle industries. Despite certain irregularities, the periodicity, as illustrated in Figure 4, is quite distinct. Low points in sheep values were reached in the years 1869, 1879, 1886, 1895, 1903, 1912, and 1922. The distances from trough to trough in the cycles vary from seven to ten years and equal distances separate peak from peak. In other words, the sheep business as far as values are concerned, improves over a period of four to five years and then retrogrades over a similar period of time. The receipt curve shows the same inverse relationship to the value curve as was illustrated

One of the characteristic features in the history of the sheep industry has been the profound change in the method of operations expressed in the shift from the production of sheep for wool to the production of lambs. The relative value of aged sheep and lambs has consequently been changing in favor of the latter. On the basis of the respective 1910 to 1914 values for sheep and lambs, sheep were selling relatively higher throughout the first decade of the century. From 1910 to 1914 values of sheep and lambs varied quite uniformly in terms of index numbers, but the war with its buying emphasis on volume again favored sheep. Since 1919, however, lambs have taken the lead and the spread has been widening in acordance with the preference of the general public favoring younger, lighter and leaner meat cuts.

Conclusions

As a result of this study, it may be maintained that distinct cyclical movements in volume of production as well as in value exist throughout the live stock industry. In detail they have been demonstrated for cattle, hogs and sheep. The value and volume cycles move in opposite directions and stand in a constant inverse relationship. Furthermore, the fluctuations, on an index number basis, are approximately of the same magnitude in both sets of curves, indicating that on the average a percentage increase or decrease in one is accompanied by a corresponding decrease or

Concerning the C.S.T.A.

NOTES

Dr. W. H. Brittain (Macdonald '11). Professor of Entomology at the Nova Scotia Agricultural College and Provincial Entomologist for Nova Scotia, has been appointed Professor of Entomology at Macdonald College. Dr. Brittain has just completed a world tour for the American Cyanimid Company, and is expected to assume his new duties on November 1st.

Dr. J. E. Lattimer (O.A.C. '14) has been appointed Asst. Professor of Economics at Macdonald College. Dr. Lattimer received his Ph.D. at the University of Wisconsin in June. He was Asst. Professor of Animal Husbandry at the University of Alberta from 1918 until 1922.

H. H. Hannam (O.A.C. '26) is now Live Stock Editor of the *Canadian Countryman*, Toronto.

H. Chabot (Laval '23) Asst. Superintendent of the Dominion Experimental Station at Cap Rouge, P.Q., is to be married on September 6th to Miss Marie Louise Ouellet. This news was received too late to publish in the French section of this issue.

W. H. Upshall (O.A.C. '23) was recently at Ottawa. He has received his M.S. from Michigan State College and is returning to the University of Maryland to continue studies there towards his Ph.D. degree. Mr. Upshall is Pomologist at the Horticultural Experiment Station, Vineland, Ont.

It is expected that the usual joint banquet of the O.A.C. Alumni Association and the C.S.T.A. will be held again this year during the Royal Winter Fair, and that the C.S.T.A. Banquet initiated last year at the Montreal Apple Show will be made an annual event by the Quebec members. Arrangements for these two events will be completed during September.

Members who want title pages for Volume VI of the magazine should apply to the General Secretary. Copies of the Annual Financial Statement of the Society are also available.

The General Secretary will spend some time with Dr. Creelman, President of the Society, during the first week in September, discussing C.S.T.A. affairs and outlining winter activities. A membership campaign will be undertaken immediately, followed by the completion of organization of the Bureau of Records and Employment.

Members should take advantage of the Text Book Club when making purchases of books for their personal use. Simply send your orders to the General Secretary and you will save 20 per cent., as well as postage charges. Be sure to give the name of the publisher, as well as the titles and authors of the books wanted.

We learn that Jack McCulloch (O.A.C. '16) is the author of an historical novel just published in New York. As soon as we have examined a copy, we will review it for the benefit of other C.S.T.A. members. Mr. McCulloch is with the McLean Publishing Company in Toronto.

The C.S.T.A. has been financing itself on a shoestring during the summer months, with the payment of annual fees delayed until the holidays were over and the members back from their field duties. We are looking for a prosperous winter.

May we again urge members to send in manuscripts of original articles, for publication in *Scientific Agriculture?* We can handle articles promptly, and would like the members to give the magazine more support than it is receiving at present.

La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

Utilité et Valeur de la Luzerne pour le Québec.

GEORGES GILBERT

Ste. Anne de la Pocatière, P.Q.

La luzerne cultivée—*(Medicago sativa-)* est originaire du Sud-Ouest de l'Asie et, depuis le début des temps elle est reconnue comme une des meilleures plantes fourragères. Pline mentionne qu'on la cultivait en Italie. Columella (1) dans un de ses douze volumes "De Re Rustica" dit que c'est le choix des fourrages parce qu'on la sème pour une décade, que l'on peut la couper quatre et même six fois par an et qu'elle est un remède pour le bétail malade.

La luzerne peut s'adapter à beaucoup des fermes du Québec mais, encore faut-il se rappeler que la réussite d'une luzernière dépend 1o-de l'homme et 2o du sol. Si l'on recherche la cause de l'insuccès enregistré par certains cultivateurs qui ont tentés cette production l'on constate que c'était dû la plus part du temps à ce qu'ils ne connaissaient pas suffisamment les exigences de la plante, les principes de sa culture et par suite ne pouvaient lui donner un traitement convenable. Les principales difficultés qu'éprouvent les cultivateurs soit par une mauvaise préparation du sol, un égouttement plus ou moins efficace, un manque de chaux ou d'engrais, une mauvaise innoculation, une semence non acclimatée, le patûrage par les animaux etc., peuvent s'éviter avec un peu d'attention.

La luzerne: culture avantageuse au point de vue de l'amélioration du sol.

Depuis bien des siècles on considère que la culture des légumineuses enrichit plutôt qu'elle n'appauvrit le sol, que les racines et les cérèales qui viennent après ces plantes donnent une plus forte récolte, mais la connaissance positive du fait et de la manière dont il se produit ne remonte qu'à quelques années. C'est une des contributions les plus importantes du dix-neuvième siècle à la science agricole.

Deux chimistes allemands, Hellriegel et Willfarth, dont les noms resteront attachés à cette mémorable découverte (1888) ont constaté dans les petites nodosités situées sur les racines, la présence d'une bactérie symbiotique appelée "Bactérium Radicicola". Ces bactéries se nourrisent de matières hydrocarbonées fournies par la plante hospitalière et, en échange elles lui passent sous forme organique, l'azote de l'air qui se trouve entre les particules du sol. Chaque espéce de légumineuses possède en propre sa bactérie, à l'exception des bactéries du trèfle d'odeur qui seules, semblent convenir à la luzerne.

Suivant C. V. Garola (2) une luzernière de 6 ans de durée ayant produit au total 24 tonnes de foin par acre laisse le sol enrichi de 409 livres d'azote ce qui correspond à une application de 40 tonnes de fumier de ferme, pour cet èlément. Van Slyke (3) parlant de l'accumulation de l'azote par les bactéries, affirme qu'en une saison, et sous des conditions favorables, les légumineuses en ramassent au profit du sol de 75 à 145 livres par acre. A Rothamsted (4) on a constaté durant 30 ans un gain de 90 livres d'azote par acre par année dans les champs portant des légumineuses.

Quand on observe le sol après un défrichement de luzerne on est frappé par la longueur, la grosseur et la quantité de racines que l'on trouve dans la couche de terre retournée.

D'après des expériences faites à la Ferme Centrale d'Ottawa (5) il ressort qu'une pousse de luzerne de 3 mois laisse par ses racines 3.120 livres de matière organique, tandis que le grand trèfle rouge n'en laissait que 1.409 livres.

Les racines de la luzerne s'enfonçant profondément—jusqu'à 30 et 40 pouces—pour puiser dans le sous-sol des éléments jusque-là inutilisables pour les autres plantes cultivées, agissent ainsi favorablement sur la texture des sols argileux. Garola (2) constate que le sol superficiel d'une luzernière de 6 ans de durée s'est enrichi de 89 lbs. de P_2O_5 et de 132 livres de K_2O par acre. Il n'y a en vérité qu'un déplacement de fertilité, mais qui a pour l'agriculteur la valeur d'une amélioration absolue, car il permet d'utiliser des forces productives que nous ne pourrions pas atteindre sans recourir à cette plante précieuse ou à ses congènères. En outre il est bien permis de croire que cette matière minérale est mise à la portée des autres plantes dans un état plus assimilable que celui où elle se trouvait dans les couches profondes du sol.

Rendements et Coût de Production

Cultivée seule ou associée aux mélanges pour prairies la luzerne se fait généralement remarquer par son fort rendement. Au Collège agricole de Guelph (6) pendant une période de 22 ans (1896 à 1919) la moyenne de rendement se chiffre à 18.83 tonnes de fourrage vert par acre et à 4.62 tonnes de foin.

En 1921, à la Ferme Expérimentale Centrale d'Ottawa (7) un champ de 40 acres faisant partie de l'assolement principal à été ensemencé en foin et a donné une production moyenne de 4.9 tonnes à l'acre. La cause évidente de ce succès doit être attribuée à l'emploi de la luzerne semée avec le mélange régulier de foin. Le tableau suivant couvrant la période décennale 1916-1925 et donnant des rendements moyens montre bien la supériorité de la luzerne au point de vue de la forte production. (8)

Récoltes	Moyenne de rendement à l'acre Canada	Québec
Foin & Trèfle ...	1.48 tonnes	1.44 tonnes
Luzerne	2.52 "	2.10 "

Trèfle et luzerne à Ste. Anne de la Pocatière—1925—Rendement de 3.10 tonnes à l'âcre obtenu en 2 coupes.

D'autre part le prix de revient d'une unité de foin de luzerne est inférieur à celui d'une unité de foin de mil. C'est ce qu'indique le tableau suivant cité de G. F. Warren (9).

	Luzerne	Foin de Mil
Nombres d'acres ...	7.75	67.4
Récolte totale	20 tonnes	94.0 tonnes
Récolte par acre ...	2.6 "	1.4
Valeur totale ...	$400.00	$1742.55
Valeur par acre ...	51.61	25.85
Coût par acre	27.14	16.72
Coût par tonne ...	10.63	12.00
Profit par acre	24.17	9.13
Profit par heure de main d'oeuvre ..	0.90	0.56

Haute valeur alimentaire.

Pour obtenir un foin de très bonne qualité, il faut couper la luzerne avant la pleine floraison. Ce faisant la digestibilité des hydrates de carbone est plus grande, la plante est plus savoureuse et elle est plus nourrissante parce qu'elle contient plus d'élèments nutritifs. Suivant Henry & Morrison la composition de la luzerne varirait suivant l'époque de la coupe dans les proportions suivantes. (10).

	Eau %	Matière minérale %	Proteine brute %	Cellulose %	Hyd. de Carb. %	Matière brasse %
Luzerne avant la floraison	6.2	10.0	22.0	20.5	37.1	4.2
Luzerne en pleine floraison	7.5	10.0	15.0	30.2	35.5	1.8
Trefle rouge avant la floraison......	10.4	7.2	18.7	18.3	41.8	3.6

S'appuyant sur ces analyses et prenant pour base les rendements des Etats-Unis, Henry & Morrison, présente le tableau suivant qui, montre qu'un acre de luzerne produirait 2.3 fois plus de proteine que la même surface en trêfle.

	Reudements moyens	Proteine brute	Matière digestible totale
Foin de luzerne	4372 lbs.	463 lbs.	2.250 lbs.
Foin de trefle	2634 "	199 "	1.136 "
Foin de mil	2340 "	70 "	1.134 "

L'ensemble de ces chiffres ne peut s'appliquer à la Province, cependant la comparaison et les différences observées conservent des proportions a peu près identiques.

De tous les foins, excepté le foin de prairie naturelle (meadow) c'est le foin de luzerne qui dégage le plus grand nombre de calories suivant H. Prentiss Armsby. (11).

F. D. Coburn (12) a trouvé que 5 tonnes de foin de luzerne contenant 1.100 livres de proteine sont égales pour la valeur de cet élèment à 3.754 livres de tourteau de lin, à 9.016 livres de son de blé, à 16.176 livres de foin de trêfle rouge et à 32.285 livres de foin de mil. Par sa grande teneur en matières proteiques, la luzerne constitue un aliment très recherché pour les animaux producteurs de lait ou de viande et par sa richesse en matière minérale elle rentre dans la catégorie des aliments indispensables pour aider la formation du foetus chez les femelles en gestation et pour favoriser le developpement du squelette chez les animaux en croissance. D'après le Dr. Klimmer (13) un bon foin de luzerne fauché avant la floraison contiendrait 0.78% de chaux et 0.2% d'acide phosphorique, tandis que le trefle rouge n'atteindrait seulement que 0.47% pour la chaux et 0.13% pour l'acide phosphorique. Suivant la Station Expérimentale de l'Ohio, la luzerne serait encore plus riche en chaux et en acide phosphorique. Elle renfermerait 1.95% de CaO et 0.46% de P_2O_5. (16).

Utilité et emploi de la luzerne sur la ferme.

Arrivé aux premiers beaux jours, les reserves fourragères commencent à s'épuiser et souvent l'on n'attend pas que les fleurs s'épanouissent pour faucher la luzerne et la faire intervenir dans la nourriture du bétail. Sous forme de fourrage vert il ne faut l'introduire que peu à peu, car presqu'autant que le trêfle elle peut causée la météorisation.

La luzerne est le fourrage le plus apprécié des vaches laitieres parce qu'elle est savoureuse, facilement digestible, lègérement laxative, très riche en proteine, en vitamines, en matière minèrale assimilable, spécialement en chaux.

Elle est économique en ce sens qu'elle permet de diminuer la quantité de concentrés, et qu'elle fournit la matière azotée à un prix plus bas que ces derniers.

La Station Expérimentale du Kansas (14) a trouvé que le beurre était produit à meilleur compte quand la ration comprenait de la luzerne plutôt que d'être balancée par des concentrés.

Les chevaux auraient avantage à recevoir un peu de foin de légumineuses. La luzerne convient particulièrement bien pour les juments poulinières, les poulains et les chevaux au travail léger. Henry (10) peut dire dans "Feeds & Feeding" que l'alimentation à la luzerne à révolutionné l'industrie et l'engraissement des moutons dans l'Ouest des Etats-Unis. La luzerne verte fait développer merveilleusement les agneaux. Dans l'engraissement de ceux-ci le foin de luzerne essayé comparativement à d'autres fourrages, à la station expérimentale de l'Ile du Prince Edouard et ailleurs a fait faire les gains les plus rapides et les plus économiques.

La luzerne est un des rares gros fourrages qui puissent entrer dans l'alimentation des porcs. Comme pâturage elle a été essayée à la Ferme Centrale d'Ottawa et un âcre de luzerne aurait fait économiser 800 livres de grain.

Dans la production du porc à bacon elle peut réduire le coût de production de 25 à 50% en comparaison avec des porcs nourris au grain seul.

A la Station Expérimentale du Kansas (15) à la suite d'expériences on tira les conclusions suivantes: Les porcs recevant de la luzerne en plus de leur ration de mais gagnèrent une moyenne de 90.9 livres en 9 semaines tandis que ceux ne recevant que du mais ne gagnèrent que 52 livres.

Verte et hachée, la luzerne constitue la source de verdure par excellence pour les volailles et surtout pour les jeunes poulets.

Convenant admirablement bien à tous les animaux composant le cheptel des fermes, donnant de forts rendements d'un foin riche et apprecié, la luzerne se place au premier rang des plantes, que l'on devrait rechercher si nous voulons organiser la production fourragère d'une manière économique et permanente.

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(14) Bull. 1229. Utilisation of Alfalfa. U.S. D.A.
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NOUVELLES DE NOS MEMBRES

Le 12 août a eu lieu, à Montreal, dans la chapelle de l'Immaculée Conception, le mariage de monsieur L.Ph. Roy, Chef du Service de la Grande Culture au Départment de Québec et Vice-président de notre société, avec mademoiselle Boileau.

La bénédiction nuptiale fut donnée par le R. P. Léopold, directeur de l'Institut Agricole d'Oka. Notre confrère, qui compte dans la C.S.T.A. autant d'amis qu'il connait de membres, peut être certain que des voeux de bonheur nombreux et cordiaux les accompagnent, lui et sa jeune épouse, dans le chemin de l'hymen.

Nous apprenons que monsieur Lionel Daviault, B.S.A., de la promotion de 1924 à l'Institut Agricole d'Oka, actuellement au Collège Macdonald, vient d'obtenir du gouvernement de la province de Québec une bourse pour aller étudier en Europe. On sait que le comarade Daviault se spécialise dans l'étude de l'entomologie.

The Interpretation of the Feeding Trial.

E. W. CRAMPTON

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For the past several years Experiment Sta- n workers have concerned themselves with ıny and various trials in an attempt to de- rmine the relative feeding value of those pro- cts which are or which may be used for ani- ıl foods. Much money has been spent on ex- riments, the results of which have not proven fallible, and farmers for some time looked th askance on recommendations made in ɜw of conclusions drawn from experiment ıtion works.

This situation demanded correction. Or- nizations interested in animal production ıde recommendations as to procedure in ɜding trials. Results obtained from single ts were carefully held until confirmed by ɔetition. Sweeping conclusions were frown- upon and in general the pendulum swung ckward about as far as it previously had ung forward.

It was early realized that the only way in ich feeding trial data could be strengthen- in reliability was via larger numbers. ɔre animals must be submitted to the same ɔerimental conditions in order that the ures representing their average perform- ɔe would be closer to expectations when the ıditions of the trial were repeated. This of ırse is quite logical when we remember the ıracteristics of averages. Averages always rease in reliability as the number of obser- ions involved increases. Just so long as s the average performance of a group of mals by which any particular condition to ich the group is subjected is to be measur- then the larger the group, the more reli- e may we expect the average obtained to be.

The necessity in animal work for large nbers was perhaps first realized by the eticist. From the very nature of his prob- ıs, hundreds or even thousands of observa- ıs were needed to allow even the simplest clusions to be made. The more complex problem the larger were the numbers ded for its solution. But numbers intro- e another problem.

It is not a difficult matter to get from ordinary observation a satisfactory grasp of the progress of a group of two or three individuals. Nor is it beyond the mental arithmetic stage to find an approximate average of a group of two or three numbers which may represent these individuals. As the group increases in size, however, the difficulty of obtaining a true picture of it becomes more and more serious, while to trace its movements mentally becomes practically impossible.

To meet the situation the geneticist turned to biometry, that branch of mathematics designed to make possible a bird's-eye view of a mass of data and to measure the reliability of calculations made therefrom.

Immediately we think of 'measuring the reliability of conclusions' the animal man's difficulty comes back to us. After all that is just his problem—to find something or some way by which to measure the reliability of the calculations made from animal feeding trials. Remove the effect of the element of uncertainty attached to the results of a feeding trial, by measuring it and making definite allowance for it, and one of the gravest problems of the experimental feeder is solved.

Now if mathematics can determine the reliability of figures for the geneticist, why not for the humble conductor of feeding trials?

Immediately someone says, 'because the character of the data is different.' Apparently many have said the same thing and let it go at that, judging from the little use that has been made of statistical analysis in this field of work. This, however, does not prove the question, one way or another. That there are possibilities in the scheme is evidenced by the work which has already been done toward adapting it to feeding trial data. The nail was hit on the head by those who stated that 'the character of the data is different.' But how? Specifically, what is the difference between the character of the data obtained from a feeding trial and that to which biometrical methods of analysis are now used? What are the characteristics of data to which

biometric methods can be applied? Let us see.

The particular factor most suitable, in the problem under consideration, for use in measuring the reliability of an average is the so-called pobable error. It is a calculation based on the variability of the individuals composing the group. The measure of this variability is known as the standard deviation from the mean (average). Perhaps a brief consideration of these two functions may make clearer the solution of our immediate problem.

The Standard Deviation

The significance of the variation in the gains obtained in a feeding trial is very well stated by Mitchell and Grindley (1) as follows: "The incidental and experimental conditions, constituting all individual and environmental factors that have not been kept constant throughout the lot, find direct and complete expression in the variation or dispersion of the individual gains. Hence a measure of the variations of the gains within the lot is a measure of the influence of the uncontrolled factors in the experiment which always render more or less ambiguous the conclusions ultimately deducted." Thus the standard deviation of the individual gains from their average, or mean, is a descriptive figure showing how variable the animals within the group were in their response to the conditions of the experiment. There is some evidence to indicate that the variability of the individual gains is correlated with the average rate of gain of the lot, the smaller the coefficient of variability the more satisfactory the gains. This, however, can be taken only as a general statement, for live stock are extremely variable, and while as low a variability within a group as is possible is desirable, it does not always follow that lots making the most uniform gains also make the greatest gains.

Suggestive though this figure (standard deviation) may be of the progress of the experiment and perhaps even of the reliability of the results, its value in this capacity does not end its usefulness. In fact in some cases it is chiefly of value as a stepping stone to the calculation of other factors, the principal one of which to the feeding trial analyst is the probable error.

The Probable Error

"The probable error tells us what confi ence we may place in our work, if the erro are due to chance only and not to avoidab mistakes of method........'Probable Errc is an arbitrary term used to denote the amou that must be added to or subtracted from tl observed value to obtain two limiting figur of which it may be said that there is an ev chance that the true value lies within or wit out these limits." (2).

The relation between the number of va iates included within varying multiples of tl probable error and the number in the tot population observed is the basis upon whi the reliability of an average is determine Thus from this figure (the probable erro we can calculate the necessary allowan around an average for any desired degree certainty or reliability.

An understanding of the probable error an average is simplified if we think of t average not as a definite point, but rather the mid-value of an interval. This interv is measured by the probable error. It is such size that the chances are even that a average obtained from a repetition of the tri will fall somewhere within or without limits. Thus an average gain of 60 ± pounds is interpreted as meaning that t odds are one to one that on repetition, t second trial would give an average gain lyi between 55 and 65 pounds. Stated different the chances are even that if the trial were r peated, the gain obtained would be the sar as that of the first trial within a range of fi pounds either way.

Pearl (3) states that "an experiment whi takes no account of the probable error the results is inadequate and as likely as n to lead to incorrect conclusions." This easily appreciated when we realize that it h been found that, on the average, animal fee ing trials show a variability of seventeen pe cent. in their gains. This means that in lo containing ten animals there will usually a probable error of at least three pounds f every 100 pounds gain. As will be seen lat in order to be significant a probable error three pounds necessitates an allowance some ten pounds either way from the avera obtained for that uncontrollable variabili attending all experiments of this nature.

The Limits of Practical Certainty

The term "practical certainty" suggests dds or chances for or against a given conition happening or being. The degree of exectation of a given result about which there an element of uncertainty is commonly exressed in terms of odds. Thus we hear of dds of ten to one on the race track, or we ay hear of 'no odds', which is the same as ne to one, or even chances. In biometry the liability of the various results or calculaons is also measured in terms of odds. The robable error gives us odds of one to one. more reliability than an even chance is ecessary, then increasing the size of the robable error raises the odds. It is possible, erefore, to find out how much allowance ust be made for the influence of those conitions over which we have no control, with y odds we decide are desirable. In busiess, investments carrying odds of twenty-one one are considered safe. The experimentalts, however, have demanded a narrower argin than that, and consider odds of at ast thirty to one must obtain before the reilts shall be considered significant. Such lds amount to a practical certainty. Mitchell d Grindley (4) state "The requirement of lds of at least 30:1 that a feeding experient upon repetition will duplicate the relts actually obtained, before definite conusions be drawn from it and definite remmendations be made to the farmer, seems asonable and, judging from the current actice of the investigators in various fields nploying these methods, is not by any means vere."

It may be shown mathematically that mulplying the probable error by 3.17 increases e size of this figure sufficiently that the relt, of which it is a part, is accurate or liable to the extent of a thirty to one chance its favor.

Special Data Organization Necessary

With this brief consideration of the charteristics and functions of the standard deation and the probable error, let us turn ck to the main questions in hand. As prevusly stated, a limited number of attempts ve already been made to apply biometry to eding trial data. But it has been found at 'the data are somewhat different' to that r which this scheme is applicable. Some adjustments must be made before the wheels will mesh. It would seem, however, that the efforts thus far made at modifications and correction have been made on the wrong side of the problem. It is really the data which must be reorganized rather than biometry. At least this would seem to be the simplest and most feasible plan at the present time. If it can be done, we have the possibility of measuring the reliability of our results very simply and efficiently. The presenting of a scheme for such adjustments as are necessary for certain kinds of feeding trials, is the purpose of this paper.

In an examination of the character of the data to which the application of the standard deviation and probable error are adapted, two facts stand out prominently; first, but one figure can be used to express the condition being measured, and secondly, group figures are of little use. Each individual must be recorded separately. Thus, instead of only the average gain of a group of ten steers, we must have as well the individual gains of each steer concerned. The second requirement can be met very simply. It is a matter of detail. The fact that one figure only may be used to express the condition being measured offers the real problem.

Preparation of the Data

The discussion of the preparation of feeding trial data for a statistical treatment will perhaps be simplified if an actual case is used in connection with the text. A steer feeding trial recently conducted at Macdonald College will answer our purpose for the time being. The conditions of the trial other than the particular data which are needed to illustrate the problem at hand are not relevant and will not be given.

Among the first data recorded in connection with a fattening trial are the weights. From them are calculated the gains of the steers on test. All things considered, it is the gain figure that is the most logical by which to judge the efficiency of a ration for fattening. To meet the case completely, however, one or two requirements must be satisfied. First this figure must accurately express the steer's response to the one experimental condition we are attempting to measure. Secondly it must be definitely related to the feed eaten.

In considering the first of the above stated requirements, our problem comes down to one of so adjusting the actual gain figure for each animal that the influence of all factors which effect live weight gains other than the one which we wish to measure are eliminated. First comes the question of the initial weight. Frequently it is found that in a lot of ten steers, two or more of them make the same number of pounds of gain during the test. To use this figure, however, is not always advisable. The larger steer at the start is given an unjust advantage. That is, of two steers each putting on 150 pounds of gain, one weighing 900 pounds at the start has made relatively more gain than another which weighed 1000 pounds when put onto feed. An excellent example of this situation is found in the following table taken from the trial previously mentioned:

Table I.

Weights and Gains of Steers

Lot	Steer	Initial weight	Final weight	Pounds gain	Relative gain per 1000 lbs. live weight
	1	989	1068	79	79.87
	2	1131	1241	110	97.26
	3	1077	1225	148	137.41
1	4	1068	1216	148	138.57
	5	877	1025	148	168.75
	6	994	1126	132	132.79
	7	859	998	139	156.25

For our immediate purpose it is not necessary to include the figures for Lot II at this time. In addition to the actual weights and gains obtained in this trial, there is included in the above table a column giving these gains as they appear when corrected to a constant initial weight. For two year old steers the weight of 1000 pounds has some advantages. It is very near the average weight of two year old feeder steers and is a figure easy to handle. By calculating the gains per each 1000 pounds of initial live weight all the gains are made, *directly comparable*, and each steer is credited with his real performance. Thus it is seen that steers Nos. 3, 4 and 5 did not make exactly the same efficient use of the feed they ate. (They consumed the same amounts of total feed during the trial.)

It is perhaps in order at this point to make some mention of the data included in the above table. First it is fully realized that there is a greater variability in the initi weight of the steers comprising this grou than theoretical allotment plans recommen Those who are closely connected with th actual operation of feeding trials will reali the difficulties of following, in every case, th plan which theory says is most nearly perfec Furthermore, were the data made public, th lack of uniformity in respect to the initi weights of the animals allotted to the sam groups in an average experiment would pe haps be surprising to many. Unfortunate it has been the *average initial weights be tween lots* which it has been attempted make as nearly alike as possible. This nece sitated mixing up the smaller and the larg animals in such a way as to bring the desire result. Under this plan the above mentione group would stand quite representative two year old steers, since their average initi weight is 999 pounds.

The second point has to do with the va iability of the gains. It is quite obvious th in this case the actual gains are more unifor than the relative gains. This is perhaps u fortunate in an example case, but does n change the situation in principle. The fa of the matter is that the actual gain figur *are not comparable* one to another since th are based on different initial weights. Ther fore while using the actual gains would gi us a lower probable error than that foun on the relative gains, the result is not a tr statement of the facts of the case.

Finally, and above all else, it should be r membered that the data herein presented a purely and simply illustrative of a method procedure. The discussion is in no way a attempt to justify any particular feeding tri but rather to suggest a scheme whereby su data as are obtained from such trials may b organized for the purpose of a statistic study and analysis.

Under ordinary conditions, the feed allo ed to a steer consists of several feedstuff The difference between two rations on co parative test may be (1) in total amount, (2 in varying proportions of the same feedstuff (3) in entirely different products used, (4 or in any combination of these. Likewise t gains made on a given ration are due in pa to the amount of the ration eaten, and in pa to its composition. But which of the follo ing is the heavier ration?

35 lbs. Silage		40 lbs. Silage
8 lbs. Meal	or	5 lbs. Meal
5 lbs. Hay		7 lbs. Hay

What part of the gains made on the above ıtions is to be credited to the meal and what the other ingredients? Since it is not ossible to separate the gain due to each usal factor within the ration, it becomes ecessary to find some single index for the ıtion as a whole.

Dry Matter, the Least Common Denominator

In the dry matter figure we have such an ıdex. After all it is on the amount of dry atter and its composition that gains from ed depend. Feeding standards universally se dry matter to indicate the total amounts feed needed per animal per day. In fact would often seem that too little use is made the dry matter content of a given ration hen analysing results obtained from its use. his is very likely due to our more general e of the dairy cattle standard where this em is of far less relative importance than it with sheep or hogs. For example; an exss or shortage of one pound of dry matter the ration needing but four pounds in all, a serious matter. In a cattle ration, hower, consisting normally of twenty to twentyve pounds of dry matter, a variation of ıe or even two pounds on any one day is latively unimportant, provided of course is not continued.

We have then in the dry matter requireent figure a key to the amounts of feed needby a given animal. As a single figure presenting the total amount of feed or oup of feeds eaten it is just what we have en looking for. Through it we are able to swer the first of the questions about the two tions above, (which is the heavier ration?) d we find there is practically no difference their total dry matter content. No part the difference in gains produced on them erefore would be due to difference in total ıounts of feed eaten.

In actual practice it is seldom possible to ed two groups of animals properly and ve them eat exactly the same amounts of ed over a given feeding period. Furtherore it is seldom advisable to attempt such actice because of the likelihood of interferg with the normal physiological functions involved, and thus introduce new errors of greater magnitude than those which it was intended to eliminate. It should be obvious to anyone familiar with nutrition that withholding of feeds to certain animals during the last day or two of a feeding trial for no other purpose than to make the total consumption per head exactly equal throughout the lot or group, more than defeats its purpose. There is ample experimental evidence to prove that the gains or productions of animals are too closely associated with the daily feeds eaten to be uninfluenced by any such practices. Still in more than one experiment in the past have such practices been resorted to, supposedly in an attempt to eliminate any variation in production due to differences in amounts of feed eaten.

Gain Per Unit of Dry Matter Consumed

The use of the dry matter content as a measure of the amount of feed eaten, however, solves the trouble, for then all feeds involved may be added together regardless of their nature, and we have a single figure representing the combination in question. Once the dry matter is determined it is but necessary to adjust the gains or productions as the case may be, to a constant amount of it consumed and the difficulty with unequal amounts of feed disappears. Such adjustment is made by dividing the relative gains of each steer by the dry matter consumed and multiplying the result by the new dry matter figure chosen. The result is the gain per given amount of dry matter consumed. What figure is chosen for this purpose is not critical, and for ease in calculation 1000 lbs., or 100 lbs. are the ones often used. The former is used in the case illustrating this article since it comes close to the actual amount really eaten by the steers.

The data appearing in Table I carried through this second step is given in Table II.

Table II

Lot	Steer	Relative gain per 1000 lbs. weight	Dry matter consumed	Gain per 1000 lbs. live weight dry matter consumed
	1	79.87	1317	60.64
	2	97.26	1317	73.84
	3	137.41	1317	104.33
1	4	138.57	1317	105.21
	5	168.75	1317	128.13
	6	132.79	1317	100.82
	7	156.25	1317	118.64

Case I.

	Lot I.	Lot II.	Difference
Average gain	78.9 lbs.	107.6 lbs.	28.7 lbs. or 36.4%
Dry matter eaten	420. lbs.	471. lbs.	
Gain per 100 lbs. dry matter eaten	18.8 lbs.	22.8 lbs.	4.0 lbs. or 21.3%

Case II.

	Lot I.	Lot II.	Difference
Average gain	104.6 lbs.	83.6 lbs.	21.0 lbs. or 23.9% in favor of Lot I.
Dry matter eaten	300. lbs.	224. lbs.	
Gain per 100 lbs. dry matter eaten	34.9 lbs.	37.3 lbs.	2.4 lbs. or 6.9 % in favor of Lot II.

A word of explanation may be in order here regarding the dry matter eaten as indicated in Table II. The steers in this trial were fed in individual tie stalls and were each allotted a fixed allowance of feed. They were not full fed and each steer in this lot consumed all of the feed given him. Hence the dry matter figure in this case happens to be the same for all the steers in the lot. Such however is not always the case, particularly in dairy cattle trials. In this same trial it happened that there was a slight difference in feed consumption between the two lots, which makes necessary the adjustment of the gains to a common consumption.

The need for this step is very clearly indicated in two experiments taken at random from many which show the same characteristic. (Case I and Case II above).

In Case I (above) approximately fifteen per cent of the advantage reported for Lot II was due to the simple fact that more feed (dry matter) was consumed in that lot than in Lot 1. Obviously increased gains made because of *increased amounts* of food eaten cannot be added to any additional difference in gain due to differences in the *kind* of food, and the sum total be credited entirely to either one cause or the other.

In Case II we find that the standing of the lots is reversed when the total food consumption is taken into consideration.

Application of Statistical Methods to the Data

After having made the adjustments necessary to make the gain figures of the steers all comparable one to another, first by eliminating any variability in them due to what we may call an 'unequal start', and then by correcting for any differences in total food intake, we are ready to apply our statistical formulae to measure the reliability of the results obtained. This is done by determining the extent of the variation which still remains in the gains and which is chargeable to those uncontrollable factors, the chief of which is the individuality of the steers.

Table III gives our data carried through the next step, i.e. the calculation of the standard deviation and the probable error of the mean or average gain.

Table III.

Lot	Steer	Gain per 1000 lbs. live weight per 1000 lbs. dry matter consumed	Deviation from the average d	Deviation squared d^2
1	1	60.64	38.30	1466.8
	2	73.84	25.10	630.0
	3	104.33	5.39	29.0
	4	105.21	6.27	39.3
	5	128.13	29.19	852.0
	6	100.82	1.88	3.5
	7	118.64	19.70	388.0
	M	98.94		Σ 3408.9
				σ 22.0
				P.E.M. ± 5.6

Comparison of Groups

Thus far we have dealt with the gains of but one lot of animals. The next step is to make our comparisons between groups. The first thing to do of course, is to treat the data of the second lot in exactly the same fashion as we have that of Lot I. The process

self will not need to be repeated here and ie results only will be given. When done e shall have the average gain for each lot gether with the probable errors for each. ı the case in question these figures are as ıllows:

Average gain Lot I	98.94 ± 5.61 lbs.
Average gain Lot II	58.92 ± 6.35 lbs.

From these figures it is possible to get a asonably accurate view of the reliability of e gains in live weight produced on the two tions fed in the trial in question. A much etter statement may be made on this point, owever, after one more step is taken. Since is the difference between these two groups at we are attempting to measure, the logi-l move is to find the difference which ex-ts between the gains of the two lots, together ith its probable error. The formula for is calculation and for the others discussed this paper will be found at the end of the ticle in a section by themselves. Suffice to state here that the probable error of a fference is found by adding together the uared errors of the two gains in question d extracting the square root of their sum. ıus we have in the case in hand a difference 40.02 pounds and an error of ± 8.45 unds.

As already stated, it is the duty of the obable error to tell us how much allowance ıst be made each way from a calculated erage gain for this uncontrollable variation order that the chances will be even that a cond trial will give an average falling with- its limits. But odds of 1:1 really mean thing. That is to say it is strictly a matter chance. There are no odds, so to speak. e are just as likely to be wrong as right th such a standing. No, before the experi-ntalist can afford to draw conclusions and ıke recommendations from data of feeding als he must be more certain of his ground an that it be backed up by even chances. lds of 30 to 1 have been the degree of cer-nty demanded in the results of experimen- trials with animals. The necessary allow-ce from the average performance of a oup for uncontrollable variation to give ds of 30 to 1, may be found by multiply-g the probable error by 3.17. Including this last calculation the results of our sample case appear as follows:

Average gain Lot I	98.94 ± 5.61 lbs.
Average gain Lot II	58.92 ± 6.35 lbs.
Difference	40.02 ± 8.45 lbs.
Necessary allowance for uncontrollable variation	±26.78 lbs.
Net difference attributable to difference in efficiency of ration fed to Lot I	13.24 lbs.
	or approximately 25%

Rather than to subtract from the difference the amount which must be allowed for variation, some would prefer to state the difference as it is found, and then to add that 'there must be a difference of 13.24 pounds between the averages of the two lots before the difference is significant.' One amounts to the same thing as the other in the end.

Number of Animals per Lot

After having followed the above case through to its end, there is perhaps one thing above all others which stands out about the result arrived at. It concerns the seemingly abnormal allowance demanded for the sake of reliability. It amounts to about two-thirds of the actual difference in gain between the two lots. Is it all necessary? How can it be reduced? To answer these questions brings us right back to the original problem of the animal experimenter. Not until an analysis of this kind is made does one realize how unreliable an average from few observations really is. The only way to reduce this allowance and still have the same reliability as is given by odds of 30:1 is to increase the number of animals within the lot. It has been estimated that it is impracticable to reduce the variability of the gains obtained in animal feeding trials much below 17 per cent. This means that to measure relatively small differences, a considerable number of individuals must be included in each group, or the probable error figure and consequently the size of the allowance necessary to give the odds required will be so large that the difference to be measured will not be as large as the error itself. Worked out mathematically we find that in order to measure a difference decreased by half, the number of steers in-

volved must be squared. Using the coefficients of variability which apparently represent the average of feeding trials in this respect, Mitchell and Grindley (5) have worked out the following table which may be of interest at this point:

Animals Needed per Lot.

Percent difference between average lot gains which it is desired to measure	Number animals (sheep)	Number animals (steers or hogs)
50	2	1
40	2	2
30	4	3
20	8	5
17.5	10	7
15	14	9
12.5	20	13
10	31	20
7.5	54	36
5	121	80
2.5	482	317

The authors of the above table have found that sheep are somewhat more variable than steers or hogs, which accounts for the difference in the numbers of animals needed in lots according to the kind of stock involved. It would seem from the table that there is little hope of proving slight differences between feeds with the ordinary trial using ten steers or less. If we cannot organize and finance a trial using twenty steers per lot, then we must expect, under average conditions, to have to allow enough for uncontrollable variation to mask any difference there may be up to ten percent. If we simply disregard this factor, we stand to have our conclusions fail to stand the test, which is costly to an experiment station and its staff.

Practically, it is not as difficult a situation as it might at first seem, particularly if this method of analysis is followed. It is not necessary that all twenty of the steers required be fed at the same time. In fact if all t data are made available, as this scheme nece sitates, all trials in which the same gener conditions obtain may be combined and t number problem quite satisfactorily solve For some work it is even an advantage f the animals to be separated into sever groups and fed at different places, and whe the data from each of them is standardized suggested in this discussion, such procedure possible. Thus it is not only as a means interpreting the single trial that this meth is valuable, but through its use an accura picture may be had of a group of trials, t proper combining of which is otherwise a most impossible.

Applicability to the Dairy Trial

Thus far only the fattening trial has be considered, but the method is equally appl able to the dairy trial in which the efficien of a ration is rated by the milk it will pr duce. Some special adjustments must made in the actual production figures in ord to prepare them for analysis, but otherwi the plan is the same as for a fattening tri The chief difficulty found in the dairy tr hinges on the fact that no two cows in a gro can be relied on to give milk of exactly t same quality. At least it is impracticable demand such a characteristic when alloti the groups. And since it takes energy to pr duce butter fat as well as to produce the re of the product, we find that the cow who milk tests five percent fat may be doing ju as much work as another producing doub the amount of milk but which contains f less fat. To get around this difficulty, ma experimentors express their results on t basis of feed required to produce a giv quantity of butter fat. Such practice, ho ever, is not entirely satisfactory from t farmer's point of view, for many of them not feed on the basis of fat produced, b rather on the amount of fluid milk. Furthe more the efficiency of a feed for butter production may not always be the same f milk production.

Quite recently a solution for this proble has been devised by Davidson and Gaines the University of Illinois. It consists of co recting all milk to a standard basis of fo percent fat. For a full discussion of the

rk the reader is referred to Illinois Bulle- 245. For the present purpose it is suffi- nt to present the formula and explain its rking.

To convert any milk to 'Fat Corrected Milk' is simply necessary to add together the unds of milk multiplied by .4 and the unds of fat which it contains multiplied by : or F. C. M. $=.4M \times 15F$, where M is milk in pounds and F the pounds of but- fat it contains. The authors of this for- la have found that by correcting the actual lds to pounds of Fat Corrected Milk, the oductions of cows whose milk yields are of rying fat contents are directly comparable. might be of interest to state that this ieme was invented not for use in the feed- trial, but for use in the study of the in- ritance of milk producing ability. Whether not it may some day seem advisable to ex- ess production records on this basis is not evant to this discussion, but for the object comparing the relative values of feeds and d combinations for milk production such a ieme is invaluable. Without it an awkward uation is met which thus far has not been isfactorily solved. With it the problem is simple as the fattening trial.

Since dairy cows are maintained at a con- nt body weight, except for the temporary rease attending pregnancy and for body wth in the case of heifers, live weight ns are not ordinarily considered in the erage feeding trial conducted to evaluate a d for milk production. Therefore no cor- tion for differences in initial weight are ded as in the case of the steer trial, for ile there is some small relation between of cow and production, this factor finds ression in feeding capacity, and hence is usted in the correction made for feed con- ned. This item instead of being the 'gain unit of dry matter eaten' becomes in the ry experiment, 'Fat Corrected Milk' pro- ced per unit of dry matter consumed. It is culated as in the case of the steers, by iding the F. C. M. produced by the dry tter eaten and multiplying the quotient by atever unit is decided upon as the basis on ich to work. A unit of 100 pounds dry tter has some advantage in that it leaves atively small numbers to work with.

As illustrative of the method applied to a dairy trial, the data from a recently complet- ed experiment at Macdonald College are given in the table following.

Lot I

Period	Cow	F.C.M. produced	Dry Matter consumed	F.C.M. per 100 lbs. D.M. consumed	d	d^2
	1	576	526	112.6	7.1	50.41
	2	605	545	111.0	5.5	30.25
1st	3	527	526	100.2	5.3	28.09
	4	537	511	105.1	.4	.16
	5	649	545	119.1	13.6	184.96
	1	589	506	116.4	10.9	118.81
	2	588	525	93.0	12.5	156.25
2nd	3	475	506	93.9	11.6	134.56
	4	497	506	98.2	7.3	52.29
	5	594	567	104.8	.7	.49
	1	641	508	126.2	20.7	428.49
	2	560	527	106.3	.8	.64
3rd	3	461	508	90.7	14.8	219.04
	4	512	508	103.0	2.5	6.25
	5	581	569	102.1	3.4	11.56
			M	105.5	Σ	1423.25
			N	15	σ	9.7
					P.E.M.	$\pm$ 1.69

Lot II.

The data for Lot II subjected to an analysis identical with that of Lot I, appearing above, gives the following results:

M	96.6 lbs.	σ	17.07
N	15 lbs.	P.E.M.	$\pm$2.97

Summary:

Fat Corrected Milk produced per 100 pounds of Dry Matter consumed in this ex- periment is as follows:

Lot I	Ration No. 1	105.5 $\pm$ 1.69 lbs.
Lot II	Ration No. 2	96.6 $\pm$ 2.97 lbs.
Difference		8.9 $\pm$ 3.41 lbs.
Probable Error of Difference X 3.17		10.8 lbs.

From this analysis we may arrive at the fol- lowing conclusions. There is a difference of 8.9 $\pm$ 3.41 pounds in favor of Lot I, but there must be a minimum difference of 10.8 pounds before the results can be credited to differences in the composition of the rations eaten. There is, therefore, not sufficient dif- ference indicated between the efficiency of these two rations to be measurable by this trial.

Formulae Involved in a Statistical Analysis of Feeding Trial Data

Relative gain per unit initial live weight	$\frac{\text{I.W.}}{\text{G}}$ X unit weight chosen I.W.=initial weight G = actual gain
Relative gain per unit dry matter consumed	$\frac{\text{R.G.}}{\text{D.M.}}$ X unit of dry matter chosen. R.G.=relative gain per unit initial weight D.M.=dry matter consumed
Fat Corrected Milk	.4M X 15 F M=yield of milk in lbs. F=fat contained in milk.
Fat Corrected Milk per unit Dry Matter Consumed.	$\frac{\text{F.C.M.}}{\text{D.M.}}$ X unit dry matter chosen. F.C.M. = fat corrected milk.
Standard Deviation from the Mean. (σ)	$\sqrt{\frac{\Sigma d^2}{n}}$ d = deviation from the mean n = number of observations.
Probable Error of the Mean	$\frac{\sigma}{\sqrt{n}}$ X .6745
Probable Error of Difference	$\sqrt{(p.e._1)^2 \ (p.e._2)^2}$
To change Odds from 1:1 to 30:1	P.E.M. X 3.17

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(5) Mitchell, H. H. and Grindley, H. S.—Il Agr. Exp. Sta. Bul. 165. p. 487.

Grateful acknowledgement is also hereb made of the helpful criticisms and sugge tions received from Dean H. Barton, Anim Husbandry Department and Professor I Summerby, Agronomy Department, Macdo ald College, regarding the subject as presen ed in this paper.

Trend Charts and Index Numbers for the Live Stock Industry.**

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An exact knowledge of the trends in the e stock industry is important to producers live stock as well as to those who trans- rt, sell, buy, process or consume animals d their products. It is, however, not easy gain a clear conception of the current nds in the industry, partly because the in- rmation offered consists of an unwieldy iss of confusing and often times contradic- y data, and partly because the long time nds are obscured by the effects of regular isonal fluctuations.

The Department of Live Stock Economics the International Live Stock Exposition, in der to depict the recent trends in live stock oduction and live stock values and to offer asis for intelligent judgement regarding the nificance of current happenings and the obabilities of future developments, has pre- red a set of trend charts and a set of index mbers. The former illustrates in graphic m the changes in volume of slaughter and value of each species of live stock, with rrections made for seasonal fluctuations. e latter illustrates these same trends in ular form and includes a set of composite ures signifying the situation in the live ck industry as a whole.

The United States Department of Agricul- e collects monthly, from all inspected king houses, information regarding the mber of animals slaughtered, the average e weight, the actual prices paid, etc. This ormation has been deemed the most reli- e as an indicator of marketing for slaugh- and of sales values. Slaughter figures are ferable to market receipts because the lat- frequently contain duplications. Prices d by packers are more significant than rket quotations because they, with a high gree of exactness, give the amount of money ually paid to producers for their stock. It rue that only about two-thirds of all ani- ls killed are handled by packers having vernment inspection, the rest being slaugh- ed on the farms or by local butchers. Yet, volume of uninspected slaughter is rela- ely constant, while the expansions and contractions in the live stock business are reflected primarily in the business handled by the inspected houses.

In the process of eliminating seasonal fluctuations, as well as in the preparation of all index numbers, a base period must be selected to represent a more or less typical or average condition from which deviations may be measured. It is usually the practice for this purpose to select a so-called normal year and period antedating the war. The war, however, caused such fundamental changes in the economic structure of America that it is particularly unwarranted to measure present events on the basis of conditions which existed before the great upheaval. There is no reason to expect that the old order of equilibrium will ever be restored. It is desirable that the base period shall be as representative as possible and it is therefore logical to select as the norm a recent period which, at least approximately, typifies present conditions. In this study the five year period 1921 to 1925 has been chosen.

All data used for the trend charts as well as for the index numbers have been corrected for the regularly occurring seasonal fluctuations. It is of little significance, if one wants to find out to what extent hog production is expanding or contracting, to state that hog slaughter was heavier in December than in September. The problem is whether the run of hogs in December was heavier or lighter than it ordinarily should be as compared with September figures. Several methods have been developed for the purpose of eliminating the effects of seasonal fluctuations in a set of monthly data. The one used in the present case is that of link relatives, first used by Warren M. Persons of the Harvard Committee on Economic Research. A technical description of this method may be found in a recent publication.*

** A lecture given at the Sixth Annual Convention, C.S.T.A., June, 1926.

* Tage U.H. Ellinger, "Trends in Slaughter and Cost of Live Stock since 1921", Journal of Farm Economics, Vol. VIII, 1926.

TABLE I

SEASONAL INDEXES

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Slaughter (number of animals)												
Cattle	102	82	93	90	96	94	96	104	107	124	111	101
Calves	94	86	110	114	117	108	101	96	96	107	90	82
Hogs	133	113	101	91	97	103	86	76	72	89	111	131
Sheep	104	87	97	94	99	102	105	107	110	111	92	93
Slaughter (total live weight)												
Cattle	104	84	94	92	97	94	96	103	105	121	109	101
Calves	94	80	93	91	101	100	103	109	113	126	103	87
Hogs	131	112	100	91	97	105	91	80	74	87	106	128
Sheep	110	94	104	98	98	94	96	102	106	110	92	98
Prices												
Cattle	97	99	108	112	115	110	107	102	95	86	81	88
Calves	106	118	111	103	107	101	100	96	94	88	84	93
Hogs	98	100	105	101	98	96	101	106	105	102	96	93
Sheep	106	110	116	112	109	98	95	92	88	88	89	97

A set of seasonal indexes are compu (Table 1). Corrections for seasonal flu ations are in all cases made by dividing actual figure by the corresponding seaso index and multiplying by 100. Converse all corrected figures can be transcribed b to actual data by multiplying by the seaso indexes and dividing by 100.

The trend charts (Figures 1 to 8) are ba on the number of animals slaughtered w the already described corrections made. dotted lines indicate the monthly figures wh the heavy lines display the trends more cle ly, smoothing out the petty deviations which no account can be given except from intimate knowledge of actual conditions the particular time they occurred. An ample or two will show how the trend cha should be read. If, for instance, correc cattle slaughter for a certain month is gi at 800,000 head, it means that at that parti lar time cattle production, as measured inspected cattle slaughter, was going on a rate that would make an average mont slaughter of 800,000 head or a yea slaughter of 9,600,000 head. In the same if the corrected price on cattle is placed $7.00, it means that if this price level w maintained over a year, subject only to ordinary seasonal fluctuations, the aver price for the year would be $7.00. By m tiplying by the corresponding seasonal inde it is always possible to transcribe the corr ed figures to actual figures. This is of parti lar importance if one attempts to project trend into the future. If, for instance, the tr of the curve would indicate that the correc price on cattle would strike the $8.00 mark July 1926, the actual market price at t time would be $\frac{107 \times 8.00}{100} = 8.56$, the seaso index for July being 107. Great care sho be used in attempting such forecasts and knowledge of the cyclical trends descri in the first paper should be combined with knowledge of current developments as basis for predictions.

Trends in the Cattle Industry

The trend in cattle production, based corrected slaughter figures, is illustrated Figure 1. After a decline during the year 19 the trend was reversed, the curve rising ste ly throughout the first six months of 19

nce then the trend has been slowly upwards til the present time. A distinct break in is development occurred in the winter of 24-25 when slaughter was excessively heavy, e probably to the Southwestern drought and e soft corn crop.

Cattle prices (Figure 2) reached their low- point in June, 1921. They mounted slowly during the latter half of 1921 and then remained almost level until the beginning of 1924. During that year prices receded slightly to experience another and more definite rise during 1925. During the first six months of 1926 most of the 1925 gain was wiped out in the face of exceptionally heavy marketing. The definite rise in cattle values,

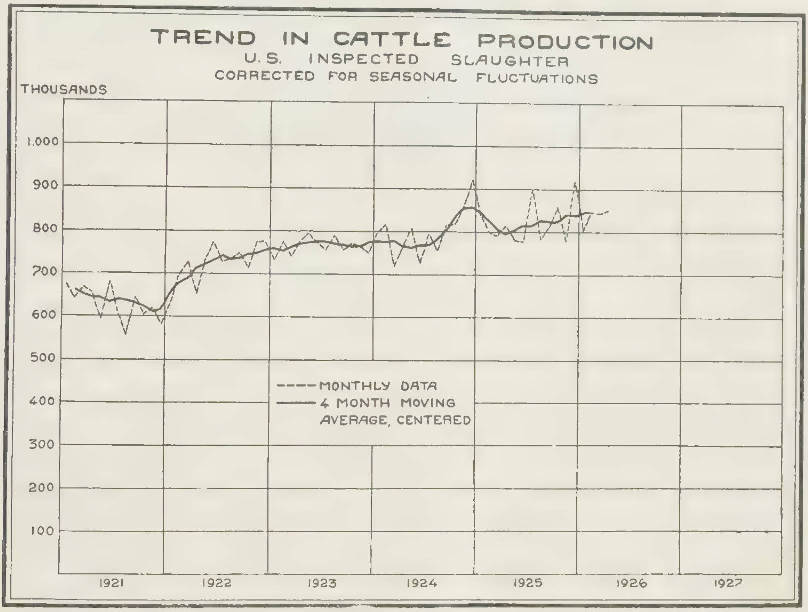

Figure 1.

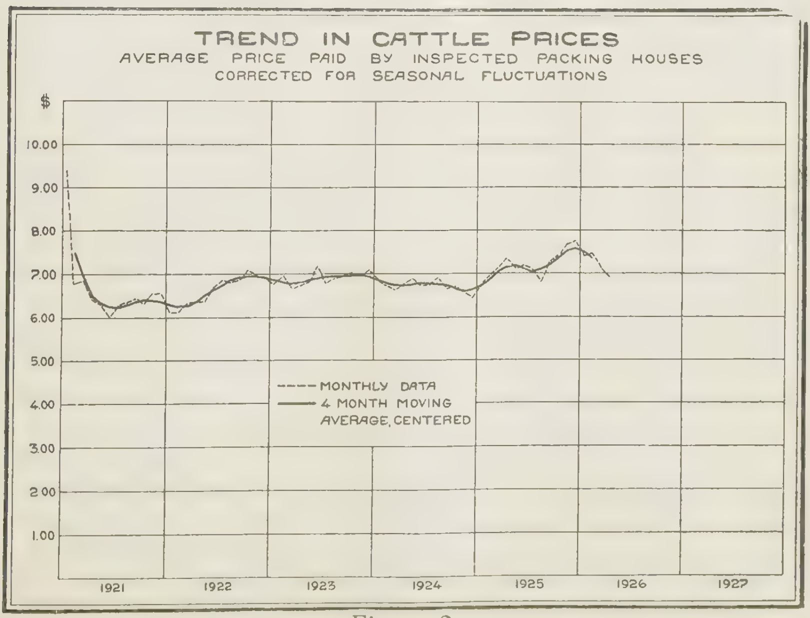

Figure 2.

which is expected by the industry, will be deferred until the upward trend in cattle slaughter is reversed or at least brought to a halt. It has always been the experience of the industry that it takes several years after the bottom of the depression has been reached until production is readjusted to a point where a significant improvement in values can take place. The price curve, despite its recent drop, is therefore likely to continue its upward movement for several years to come.

Calf production (Figure 3) has been co stantly expanding since 1921. The number animals slaughtered increased 50 per cent the course of these five years. This develo ment reflects the growing importance of t dairy industry and heavier slaughter of ran calves in the fall. Calf prices (Fig. 4) ma tained themselves at an almost constant le from 1921 until the beginning of 19 During the latter year, however, a defin rise took place.

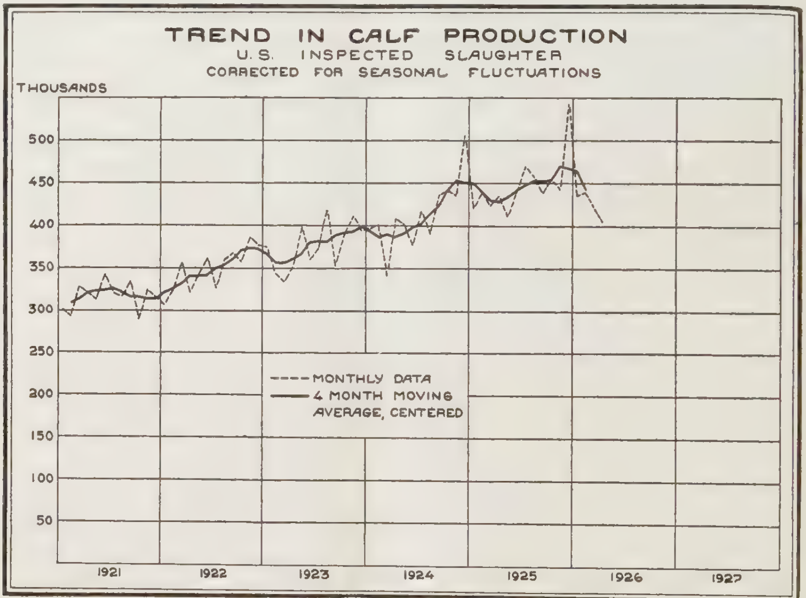

Figure 3.

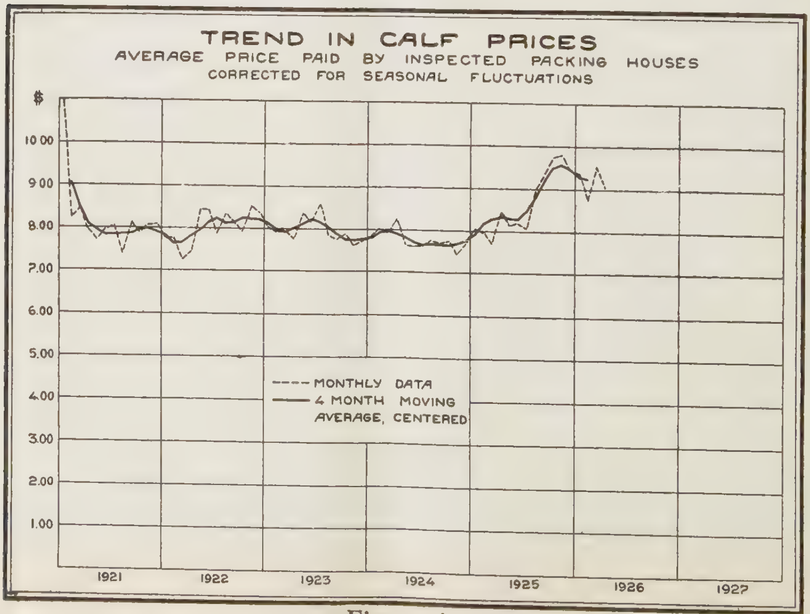

Figure 4.

Trends in the Swine Industry

The five year period, 1921 to 1925, covers entire hog cycle (Figures 5 and 6). The gnitude of the fluctuations both in volume l in prices is striking. The year 1921 was racterized by low production and also by v prices. In this year, however, corn was eptionally cheap and hog feeding offered nore profitable outlet than cash sales. As result, farmers planned a great expansion of their hog breeding activities. This policy was reflected in a heavier run of hogs in 1922. For two and one-half years production continued on an extremely high level, with hog prices correspondingly low. The resulting liquidation took place in the winter of 1924-1925 and was reflected in sharply rising prices. Since the spring of 1925, when the new low levels were reached, volume of production, as well as prices, has remained

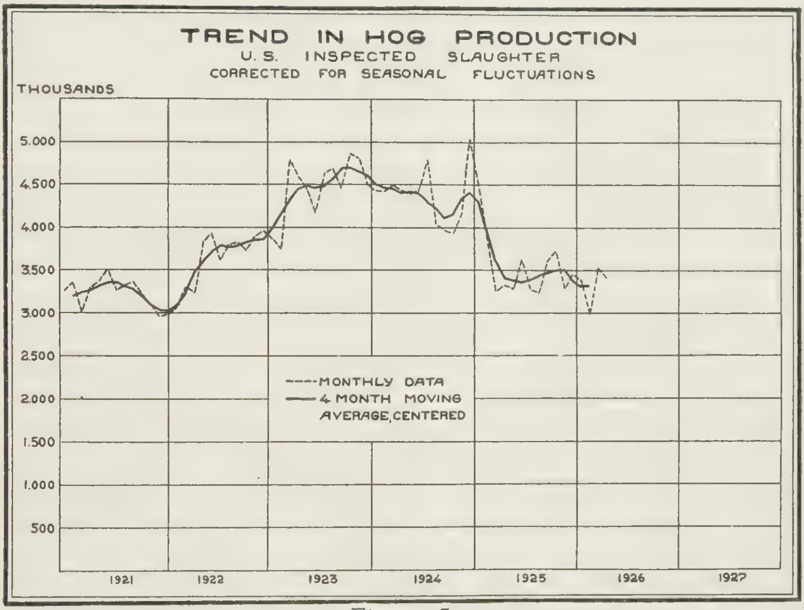

Figure 5.

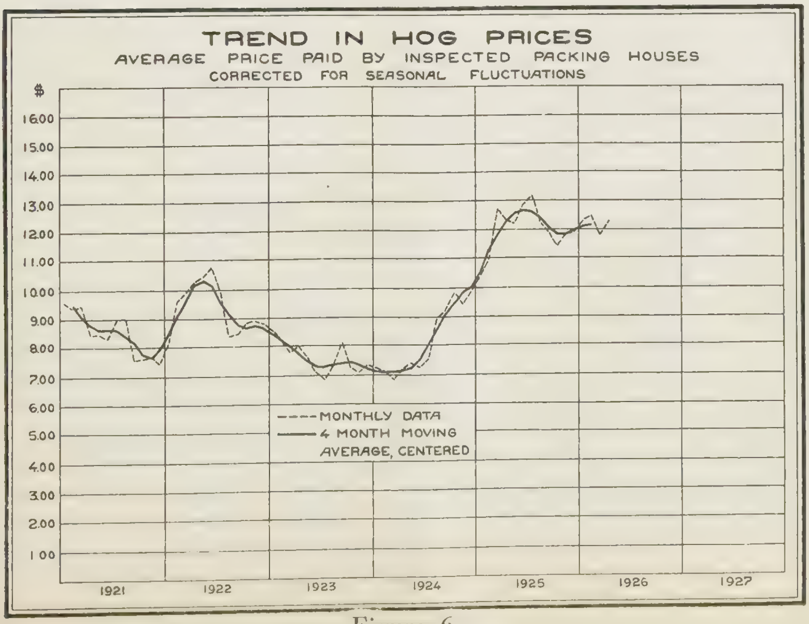

Figure 6.

fairly constant. This condition will probably continue throughout 1926 with another upward movement in volume and downward movement in prices next year.

Trends in the Sheep Industry

The year 1921 witnessed the end of the post-war depression in the sheep business. With slaughter going on at a high rate, returns we unsatisfactory (Figs. 7 & 8). Since then the i dustry has experienced four years of increa ing prosperity with mounting prices ar slaughter on a safe and conservative basis. Tl charts indicate that sheep prices are partic larly sensitive to variations in supply. Appa ently, the demand for lamb is relatively i

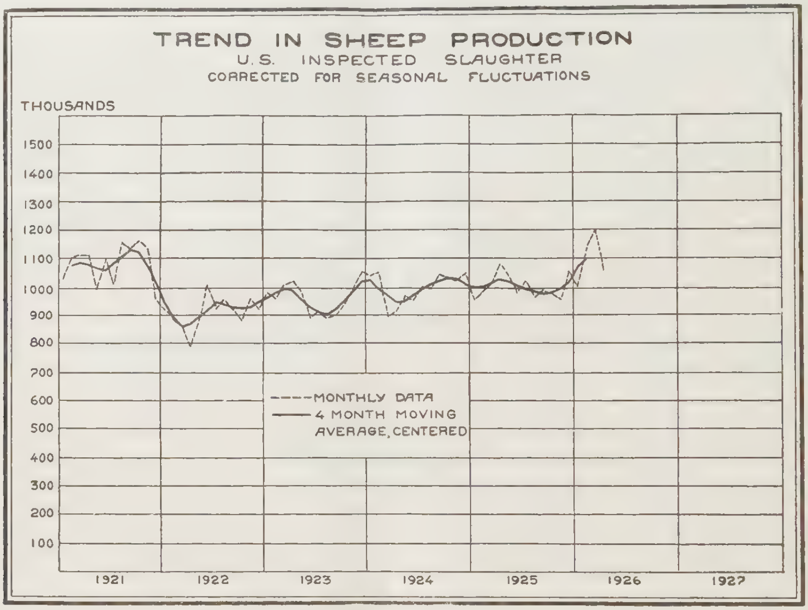

Figure 7.

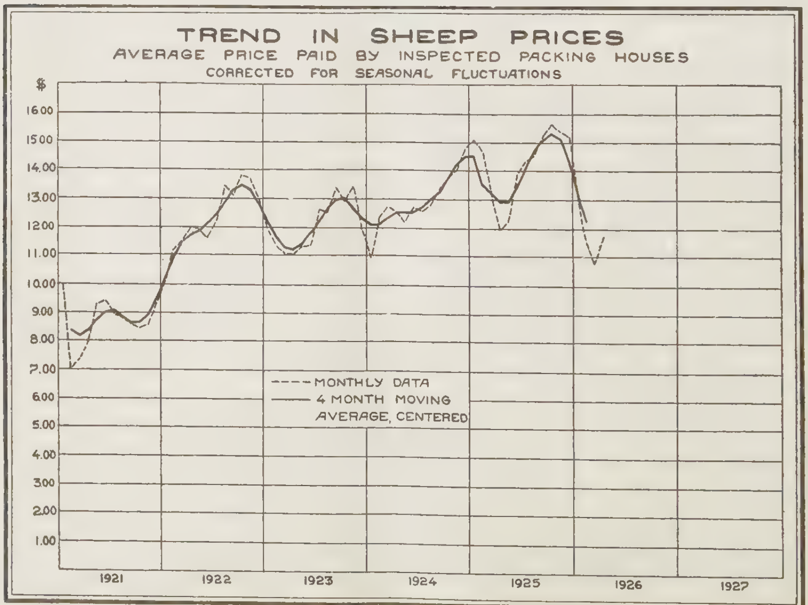

Figure 8.

TABLE 2

INTERNATIONAL LIVE STOCK EXPOSITION INDEX NUMBERS

		Price of Live Stock Sold to Inspected Packing Houses				*Volume of Inspected Slaughter (In pounds live weight)*			
		Cattle	Calves	Hogs	Sheep	Cattle	Calves	Hogs	Sheep
921	Jan.	138	135	105	83	91	78	87	107
	Feb.	100	101	103	58	86	75	89	113
	Mar.	101	104	104	61	92	85	80	115
	Apr.	94	98	92	66	90	84	86	114
	May	92	94	93	77	82	82	86	99
	June	88	98	91	78	95	91	89	108
	July	92	98	99	75	83	84	88	94
	Aug.	93	91	99	74	92	82	85	114
	Sept.	94	100	83	71	89	89	86	111
	Oct.	93	97	84	69	85	74	85	116
	Nov.	96	99	84	71	87	82	81	115
	Dec.	96	99	82	78	81	79	76	94
922	Jan.	89	95	89	84	87	77	79	92
	Feb.	90	95	105	93	94	83	80	88
	Mar.	93	89	109	96	101	91	86	87
	Apr.	93	91	113	100	90	82	84	79
	May	93	104	115	99	100	89	100	87
	June	98	104	118	96	105	93	103	99
	July	101	96	109	101	99	84	94	92
	Aug.	100	102	92	112	100	93	101	96
	Sept.	101	100	93	109	101	95	100	93
	Oct.	104	97	97	115	97	91	97	90
	Nov.	102	105	98	114	103	97	101	101
	Dec.	101	103	96	108	102	95	103	94
923	Jan.	99	99	94	99	97	96	103	102
	Feb.	102	97	90	94	102	92	99	99
	Mar.	98	97	85	92	99	90	127	101
	Apr.	98	95	87	92	102	95	121	101
	May	100	103	83	94	103	103	115	97
	June	105	100	78	94	102	96	108	93
	July	100	106	75	105	99	99	117	95
	Aug.	101	96	81	104	103	110	121	91
	Sept.	102	95	89	111	100	93	115	92
	Oct.	102	97	79	107	103	100	126	95
	Nov.	102	93	78	112	100	104	125	96
	Dec.	104	95	80	99	99	103	116	104
924	Jan.	101	96	79	91	105	107	113	104
	Feb.	99	98	78	103	107	107	114	104
	Mar.	97	98	75	106	95	94	117	91
	Apr.	99	101	79	104	100	114	116	92
	May	101	94	81	101	105	111	114	99
	June	99	93	80	106	94	104	108	96
	July	99	93	83	104	104	113	124	102
	Aug.	101	95	98	106	101	103	106	100
	Sept.	98	94	101	111	108	114	103	105
	Oct.	98	95	108	114	109	112	102	105
	Nov.	97	91	103	117	113	115	107	106
	Dec.	94	94	108	123	120	133	124	104
925	Jan.	98	99	114	125	111	113	112	97
	Feb.	102	98	120	122	106	121	99	100
	Mar.	104	107	139	110	105	119	83	105
	Apr.	107	104	135	99	108	121	87	110
	May	104	100	134	102	103	111	87	107
	June	105	100	141	116	103	120	72	99
	July	104	99	145	118	118	129	86	106
	Aug.	100	110	134	121	102	121	87	99
	Sept.	106	115	131	127	106	112	97	101
	Oct.	109	119	125	130	115	118	101	99
	Nov.	112	120	130	128	103	111	88	99
	Dec.	113	115	131	126	121	142	92	107
926	Jan.	108	115	135	111	106	115	92	104
	Feb.	109	107	137	96	111	121	81	117
	Mar.	104	117	129	89	113	120	98	123
	Apr.	101	111	135	97	112	119	95	108
	May	98	119	151	104	109	110	89	97
	June	104	121	160	117	121	124	93	109

elastic. The danger of overproduction, induced by the prolonged period of high returns, seems finally to have materialized during the winter of 1925 to 1926. Marketings have become heavier resulting in lower prices. In view of the fact that the sheep cycle usually covers four to five years of relatively high prices, followed by as many with lower prices, it is evident that the situation calls for a cautious and conservative policy on the part of the producers. One evidence of the tendency sheepmen to adopt this viewpoint is the r duced spring volume of contracts for lan for fall feed-lots, and the lower prices which these contracts have been made.

The Making of Index Numbers for th Live Stock Industry

In the preparation of the index numbe the average volume of slaughter (in terms

TABLE 3

INTERNATIONAL LIVE STOCK EXPOSITION INDEX NUMBERS

	1921	1922	1923	1924	1925	1926
Volume of Inspected Slaughter						
January	89	82	101	109	111	98
February	89	85	100	110	102	94
March	86	91	114	106	93	105
April	89	85	112	108	96	102
May	85	99	109	110	94	96
June	92	103	104	102	98	103
July	87	95	108	115	99	—
August	89	100	112	104	94	—
September	89	100	107	105	101	—
October	86	96	114	105	106	—
November	85	102	113	109	94	—
December	79	102	108	122	104	—
Live Stock Prices						
January	116	89	96	88	109	123
February	98	98	95	87	113	122
March	99	101	90	85	123	117
April	91	104	92	88	121	119
May	92	106	90	90	120	127
June	90	109	89	88	125	135
July	95	105	86	90	125	—
August	94	96	89	100	120	—
September	87	97	95	100	121	—
October	86	100	89	104	120	—
November	88	101	88	101	123	—
December	87	99	90	104	123	—
Total Value of Live Stock Slaughtered						
January	103	73	97	96	121	121
February	87	83	95	96	115	115
March	85	92	103	90	114	123
April	81	88	103	95	116	121
May	78	105	98	99	113	122
June	83	112	93	90	123	139
July	83	100	93	104	124	—
August	84	96	100	104	113	—
September	77	97	102	105	122	—
October	74	96	101	109	127	—
November	75	103	99	110	116	—
December	69	101	97	127	128	—

oounds live weight) and average prices for he five years 1921 to 1925 have been used as oases. Eight sets of index numbers (or rather elatives) have been computed by dividing he monthly data, corrected for seasonal flucuations, by the corresponding base figures. These simple indexes are listed in Table 2. The composite index numbers are computed ısing Irving Fisher's "ideal" formula, which pplied to prices reads as follows:

$$\sqrt{\frac{\Sigma p_1 q_0}{\Sigma p_0 q_0} \times \frac{\Sigma p_1 q_1}{\Sigma p_0 q_1}}$$

By changing the formula slightly it is also applicable to measure changes in volume of production. The formula now reads:

$$\sqrt{\frac{\Sigma p_0 q_1}{\Sigma p_0 q_0} \times \frac{\Sigma p_1 q_1}{\Sigma p_1 q_0}}$$

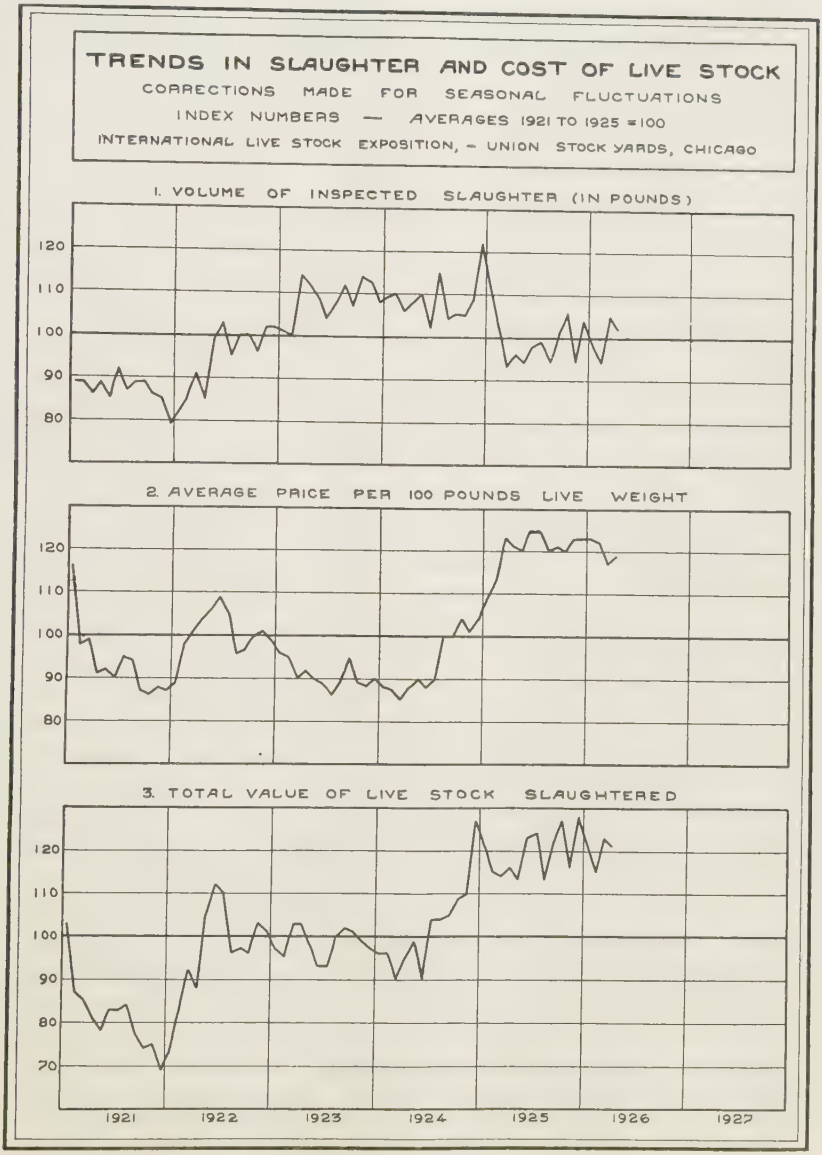

Figure 9.

By simply multiplying the indexes for volume with the corresponding indexes for price, a third set of index numbers is obtained, indicating the total value of all live stock slaughtered. These three sets of index numbers which are published monthly from the Department of Live Stock Economics of the International Live Stock Exposition, are listed in Table 3.

Comparing the two upper curves in Figure 9, it is apparent that a certain inverse relationship exists between volume and price, expressing the well known fact that an increase in offerings tends to depress the price, while relative scarcity has the opposite effect. In this particular case, however, this rule does not seem to hold universally. In 1921, for instance, the volume offered for sale was 15 per cent under average and the price was about 10 per cent below average. In 1925 and the first half of 1926, on the other hand, the supplies have been approximately average while prices have been 20 per cent over average. The explanation is a simple one; i.e., not only supply but also demand influences the price level. In 1921, we were in a period of severe economic depression while for the last year and a half a high degree of prosperity has obtained.

The dependency of live stock values on general business prosperity is strikingly illustrated in Figure 10. In this illustration the total-value-of-live-stock curve is compared with the Harvard Business Curve selected as an indicator of general business conditions. The parallelism between the two curves is striking. The correlation between the two is +.85 with a one month's lag on the part of the business curve. It appears plainly that the live stock industry has gradually recovered from its severe post-war depression and is at the present time supported at a high level by an exceedingly prosperous consuming public.

Students of live stock markets should not only be well informed regarding production trends, but also be intimately familiar with the trends in general business conditions, especially as they affect the purchasing power of the consuming public. No formula exists whereby it is possible to make safe predictions regarding the future. . Statistical studies, however, can be helpful in preparing and analyzing the data upon which a sound judgement may be based.

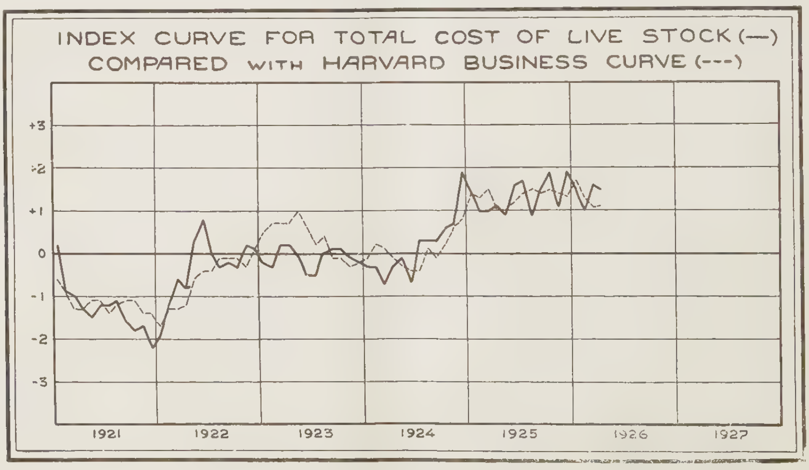

Figure 10.

A Summary of Recent Work on the Vitamins and Other Factors Connected with the Prevention and Cure of Rickets.

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"Mute and still, by night and by day, labor goes on in the workshops of life. Here an animal grows, there a plant. The wonder of the work is not less in the smallest being than in the largest."

—*Rubner.*

Noteworthy progress has been taking place within recent years in the chemistry of animal nutrition and physiology. The field is a very large one, embracing many problems, each needing particular methods of attack and technique for its solution.

Results obtained may often be not as spectacular as those in other branches of science. The launching of an airship, or some new device in wireless telegraphy will likely attract more attention from the public. Yet their real influence on the common welfare may not be any greater than that of some less noticed discovery made in the science of nutrition.

Vitamin B, Antineuritic, and Vitamin C, Antiscorbutic

For some years many investigators have been studying the so-called "deficiency diseases", which are caused by the lack of certain substances in the food. Funk in 1910 proposed the term "vitamin" for these substances, which, though present in food stuffs only in minute amounts, are essential for the maintenance of normal metabolism in the body. Rickets, beri-beri, pellagra and scurvy are all examples of "deficiency disease". Beri-beri is a condition of nerve degeneration common in certain parts of India and other eastern countries, where the native population exists on a scanty diet which largely consists of polished rice. The factor which will prevent or cure this condition is the "water-soluble antineuritic" vitamin B*, which is present in the bran of the rice and that of other grains.

* Such terms as "vitamin A, B, and C" are, of course, provisional until more exact knowledge is obtained about these substances.

The factor preventive of scurvy, is the "water-soluble vitamin C" found in lemons, oranges and many other fruits and vegetables.

Both beri-beri,—also termed "polyneuritis" —and scurvy can be produced experimentally in animals by feeding them rations lacking, respectively, vitamin B or vitamin C. A great deal of work has been done on the study of these vitamins, but it is not the purpose of this paper to deal with them at any further length.

Vitamin D, Antirachitic

Recent work has shown that the so-called "fat-soluble A" antixerotic vitamin, consists of two distinct factors which may exist together or quite separate from each other.

These are, (1) Vitamin A. The factor essential for growth, lack of which in the diet produces an inflammation of the eyes, termed xerophthalmia, with cessation of growth, the animal remaining in a stunted and weakened condition.

(2) The antirachitic factor, which is also necessary in the diet for growth and particularly for the proper formation of bone and now spoken of as "Vitamin D".

Owing to the close combination in which these two are usually found, they were formerly taken to be one substance. Experimental work has shown that these two factors will not supplement each other. That is, the xerophthalmia-curing or -preventing factor will not cure rickets nor prevent its development in an animal kept in a ration deficient in the antirachitic factor, whilst the latter will not cure xerophthalmia.

This antirachitic substance can be obtained in a concentrated form by extracting codliver oil with 95% alcohol and then saponifying the extract with sodium hydrate. The active principle remains in the unsaponifiable residue and can be extracted with acetone. By

this method Zucker has obtained a preparation of the antirachitic material which, he claims, after being diluted 1:1000 is as active as the original codliver oil.

Zucker (1) states that this purified material is not toxic in doses of more than 50 times the curative dose used in treating rickets. It is also reported to be quite free from the fat-soluble A factor, as it will not cure xerophthalmia in cases in which a subsequent treatment with butter fat does relieve the condition.

The effect of the lack of the factors supplied by codliver oil upon young animals has been well demonstrated by Steenbock, Jones and Hart (2). Puppies fed on a ration of cooked cornmeal and oatmeal along with casein, common salt, calcium phosphate and skim milk, failed to grow and developed tetany. The calcium and phosphorus content of the blood was much reduced and the bones were poorly calcified as shown by their ash content and X-ray pictures. The addition of 5 c.c. of codliver oil per day or the unsaponifiable extract from the latter produced good growth.

Experiments by several investigators have shown that direct sunlight or light from an electric arc has very decided antirachitic properties. In one of their experiments Hart, Steenbock and Lepkovsky (3) find that "light can play a very important part in the rearing of baby chicks, acting as the supplement or the equivalent to the antirachitic factor of foodstuffs". They also observe that "one half hour daily exposure to direct sunlight was much more potent in furnishing the antirachitic factor than was 5% of a synthetic ration fed as fresh green clover, calculated on the basis of the dry weight of the clover.

The antirachitic properties of green plant tissue have been studied by Shipley, Kinney & McCollum (4) and also by Bethke, Kennard and Kirk; (5). The former, in feeding rats suffering from rickets a ration fortified with ether extracts of alfalfa and clover plants, found that some calcification took place in 7 days, with complete healing in 33 days.

Bethke, Kennard and Kirk in their work on the relation of sunlight and green clover to leg weakness in chicks, find that "by supplying green plant tissue (clover) we not only prolonged life beyond the sixth week but also obtained increased growth to the extent of 15 to 40 grams per chick. This prolongation of life and increased growth we believe due in part to increased amounts of fat-soluble A vitamin in which green plant tissue abounds and also to some extent to increased intake of the antirachitic factor".

They also conclude that half an hour of direct sunlight proved more beneficial in preventing leg weakness than 18% green clover calculated on the dry weight of the clover; and also that, "sunlight appeared not only to act as a calcifying agent of the skeletal tissue, thus preventing leg weakness, but also seemed to possess growth-promoting properties".

Steenbock and Black (6) have found that antirachitic properties can be imparted to various foods by exposure to the electrical arc light. In their summary of one series of experiments they state:

"By irradiation with the quartz mercury vapour lamp, rat rations can be activated, making them growth-promoting and bone-calcifying to the same degree as when rats are irradicated directly. This activation takes place when the ration is irradiated in an open dish or in a stoppered pyrex or quartz flask filled with air or carbon dioxide, but not in a brown glass bottle. The activation is not destroyed by subjecting the ration to a vacuum, heating it for 45 minutes at 96°C. or letting it stand at room temperature for 24 hours.

"Confirming the observations of Goldblatt and Soames, liver taken from irradiated rats is growth-promoting, while liver from non-irradiated rats is inactive. Inactive muscle taken from the body and exposed to the lamp becomes activated. Activated liver is not destroyed by drying at 96°C. for 24 hours."

Similar experiments have been made by Hess and Weinstock (7). They have been able to activate cottonseed oil and the green or etiolated leaves of wheat and lettuce, substances not naturally antirachitic, by exposure to the light of the mercury vapour lamp. They were also able to activate patent white flour, the kind employed in the rickets-producing diet used in their experiments. The flour was irradiated separately for half an hour and then combined with the salt mixture in the usual ratio of 95%. The effect of the irradiation was to change the diet from a

markedly rickets-producnig to a rickets-protective diet.

In discussing this experiment, the investigators draw attention to the fact that on several former occasions the standard "rickets diet" either failed to produce rickets or did so to only a slight degree and state: "This irregularity, which temporarily has invalidated all experiments, has occurred most often in the spring and summer months. It has never been satisfactorily explained. In view of the possibility of activating flour by means of irradiation, the question arises as to whether such irregularities may be due to differences in the flour brought about by the solar rays".

In connection with these remarks, the interesting work of Steenbock and co-workers on the relation of light to the antirachitic properties of hay should be noted. (See below.)

Hess and Weinstock have also been able to activate linseed oil by irradiation, and find that the antirachitic principle is formed in the non-saponifiable fraction of the oil. In a continuation of their work they also were able to activate cholesterol and phytosterol in the same way, the latter compound being the main constituent of the nonsaponifiable part of vegetable oils. The antirachitic power could not be produced by irradiation in chlorophyll, hemoglobin, red blood cells, the phosphatide of egg yolk, or glycerol.

That the direct action of ultraviolet light will prevent the development of rickets in chickens kept on a rickets diet has been shown by Hughes, Nitcher, and Titus, (9) who also found that irradiated air alone had no beneficial effect. The chicks exposed to the irradiated air develop rickets to the same extent as the control chicks.

The extensive experiments of Steenbock and co-workers (8) on "The antirochitic properties of hays as related to climatic conditions with some observations on the effect of irradiation with ultraviolet light" has been mentioned above. They state that "the rat represents a most sensitive reactor to the antirachitic factor when this is added to our standard rickets-producing ration. Certainly our results have been far more analytical than those obtained with the goat and chick whose needs are apparently of such order that no difference in reaction to rather large additions was secured." Also: "We consider it a significant matter that our data have shown that hays vary tremendously in antirachitic content depending upon their exposure to sunlight".

In a summary of their work they also state: "The antirachitic properties of hays are related to their exposure to sunlight. Clover hay made with exposure to sunlight showed considerable calcifying power, while the clover hay made in the dark was inactive.

"Clover hay excessively weathered was reduced in antirachitic action as compared with hay less exposed to dew and rain.

"The antirachitic action of the hay excessively weathered was readily increased by irradiating it with a quartz mercury-vapour light.

"Direct irradiation of a milking goat with ultraviolet light from a quartz mercury-vapor lamp brought about a positive calcium balance even when the animal was receiving the weathered clover which by itself had no beneficial effect."

In another series of experiments Steenbock and Hart have been able to increase greatly the antirachitic value of milk by direct irradiation and by irradiation of the animal (10). "By exposure to the radiations of a quartz mercury vapor lamp, the antirachitic properties of cow's milk were increased eight or more times. Under the same conditions goat's milk increased in activity about 24 times. This increase in activity can also be induced rather promptly, though to a lesser degree, by direct irradiation of the animal".

Work by the same experimenters on the "Influence of ultraviolet light on the production, hatchability and fertility of the egg" (11) has shown that egg production in hens is dependent to a large extent on the supply of antirachitic factor either in the diet. or as light.

They find that, "hens receiving ultraviolet light in January laid abundantly, while those not receiving any light ceased to lay almost altogether. Feeding codliver oil or irradiating hens with ultraviolet light after long treatment with a rachitic ration with resultant decrease in egg production again stimulates and increases egg production.

"Irradiating hens with ultraviolet light greatly improves the hatchability of the eggs up to 70% as compared to nearly zero in

the absence of the light". The shell of the eggs from the irradiated hens contained much more lime than the shells of the untreated hens. (11).

Experiments at the University of Maine on the effect of sunlight and electric arc light on young chickens have shown that sunlight which has passed through window glass does not have any beneficial effect on rickety chickens. This is due to the absorption of the ultraviolet light by the glass. A good review of the subject is given in an article by W. T. Bovie (12) with a discussion of theories on the antirachitic action of light.

Reviewing briefly the symptom complex of rickets, this is a disease affecting mostly children and young animals. It is a disorder of the calcium and phosphorus metabolism of the body (13).

The bones of young animals are at first soft, they become hard by calcification, that is the deposition of mineral matter within the cells. Of this mineral matter, 85% consists of calcium phosphate, but other salts are also present in a constant proportion.

During rickets there is insufficient deposition of calcium phosphate in the bones, so that they remain soft and weak. In some cases hardened bone may become soft again by the calcium salts being dissolved away.

For the proper growth and functioning of the body, there must be not only enough of the various salts needed but each must be present in a certain proportion or balance in relation to the other elements. If this balance is distributed, a number of different functions in the body are upset, one of which is the action of the nervous system.

An increase in the proportion of the sodium and potassium causes an increase in the irritability of the nervous system, which results in a hypersensitivity named tetany and shown in convulsions. Calcium decreases this irritability. Convulsions often occur with rickets, as both are due to calcium deficiency.

There may be sufficient calcium and phosphorus in the diet of a child or young animal yet inability to make use of these elements will result in rickets. This inability to make use of the calcium salts in the food is often due to lack of the antirachitic factor, either in the food,—now termed vitamin D—or as direct sunlight.

The remedy in such a case is to supply the missing factor in one form or another. It has been shown that children having rickets can be cured by feeding codliver oil or treatment with sunlight or arc light.

Vitamin A, Antixerotic and Growth-promoting

The xerophthalmia-curing vitamin A, which is also known as the growth-promoting factor, is usually found closely associated with vitamin D. Most animal fats and fish oils are more or less rich in vitamin A, particularly codliver oil and butter fat. The green leaf tissues of many plants also contain decided amounts of this vitamin A.

This factor can be extracted fairly readily from the animal fats with ether, but for plant tissues alcohol has been found a much more effective solvent. Steenbock and Boutwell were able to make ether extracts of vitamin A from alfalfa but for its extraction from carrots they had to use 95% alcohol. It appears from such experiments that the solubility of A varies with the condition in which it is found.

Hart and Steenbock have shown that chicks need vitamin A (supplied in dried green clover) as well as the antirachitic factor (supplied as ultraviolet light) for normal development (14). If either of these factors was omitted the birds weakened and died prematurely. The amount of dried clover sufficient for the vitamin A requirements of the birds was 1.5% of the ration.

Hopkins first showed (1920) that oxidation destroys vitamin A. He showed that if butter is oxidized whilst hot the vitamin is easily destroyed, so that the butter fat could not induce growth or cure ophthalmia of dietary origin.

Similarly McCollum (15) found that if codliver oil had air blown through it at 100°C. for about 12 hours, it lost its power of curing xerophthalmia, yet its antirachitic property was only slightly decreased.

Takahashi (1924) has prepared a very concentrated form of vitamin A from codliver oil, butter fat and green leaves. He calls the material "biosterin" and believes it to be an alcohol with two OH groups. It has the formula $C_{22}H_{44}O_2$ and a molecular weight of about 400. Health and growth are maintain-

ed in a rat when its diet contains only .0001% biosterin. The effect is said to be proportional to its concentration in the diet up to 0.05%, but an amount greater than this has an unfavorable effect.

Takahashi has prepared the benzoate, acetate, hexabromide, and ozonide of this material, which appears to be closely related to cholesterol. Biosterin affects a photographic plate so that the image of a screen held between the two appears on the plate. This takes place even when the plate is well wrapped in black paper, or the biosterin sealed in a quartz tube and the plate exposed to it in a dark room (15).

Most of the work reviewed so far has been done on this continent. Dr. Harriet Chick and co-workers of the Lister Institute, London, in their studies (1922) of Vienna children suffering from rickets, found that the condition could be cured or prevented by giving cod liver oil, or more milk in the diet and less carbohydrates. They also found that sunlight or radiation from the mercury vapor lamp improved the condition of the children to a marked extent. They noticed that rickets was most prevalent during the winter and spring months, even amongst children living under hygienic conditions and getting some fresh milk in their diet. More recently Dr. Chick and M. H. Roscoe studying the vitamin content of spinach, find that the fresh leaves are rich in vitamin A. The antirichitic factor cannot be demonstrated in spinach grown in the winter, spring or autumn, but does exist to an appreciable extent in summer-grown spinach.

Margaret Boas (16) — Lister Institute — working on the same subject finds that an improvement in the general health of rats with an increase in the rate of growth of both the skeletons and the whole body results from the addition of codliver oil to a ration deficient in fat-soluble vitamin.

The fresh leaves of winter-grown spinach added to the diet caused an even greater improvement in the well-being of the rats and in the rate of growth. The weight of the skeleton was not, however, proportionally increased. The conclusion is drawn that winter spinach contains an amount of vitamin D which is negligible compared with its content of vitamin A.

Both codliver oil and spinach when added to a diet deficient in fat-soluble vitamin, cause an increase in the amount of phosphorus excreted in the urine at the expense of that excreted in the feces.

Among other investigators who have done notable work on the vitamins in Great Britain are E. Mellanby, J. C. Drummond and S. Zilva. Mellanby (1919) drew attention to the fact that in the west of Ireland where the death rate among children is only about 30 per 1000, rickets is almost absent. This is considered due to the fact that the land in that district, being poor and rough and only fit for grazing, the number of sheep and cattle per head of population is high. It is true generally that in other countries where similar conditions prevail, as Northern Scotland, Scandinavia, and the Balkan regions, good physical development is seen in the people and rickets is rare among the children. Such people, living away from civilization, have to depend largely on locally grown food produce, including dairy products. That is, their diet consists of natural foods instead of the refined foods used so much in cities.

Mellanby found the same to be true regarding the absence of rickets in the Island of Lewis in the Hebrides. The children are brought up under very unhygienic conditions, the homes being dirty, dark and poorly ventilated. The rarity of rickets is due to the diet which consists mostly of fish, oatmeal, cod livers, milk, turnips and potatoes. Such diet, though perhaps unattractive to the average city dweller, is yet biologically well-balanced.

Drummond, Zilva and Golding (17) in a report on "Codliver oil in the feeding of Farm Animals", state "In our opinion the administration of codliver oil of good quality in rather large doses (1½—2 oz. daily) is of great value to sows in pig and enables them to secrete milk rich in vitamin A, thereby giving their young ones a better start".

They also advise feeding codliver oil to cows in winter so as to keep up the vitamin A content of the milk.

They found that cows liked the oil, which was given in doses of ½ to 2 oz. daily, and that no trace of taint or flavour was impart-

ed to the milk even when the dose was raised to 4 oz. per day.

Investigations on various problems in animal nutrition are being carried on at the Rowett Research Institute, Aberdeen, where valuable work has already been done.

The antirachitic factor enables the body to make more efficient use of calcium and phosphorus especially when these only exist in the diet in smaller amounts than the optimum for normal bodily requirements.

If these are absent altogether, rickets will develop in spite of plenty of vitamin D in the diet. This fact is emphasized in a report on "The Importance of the inorganic constituents of the food in nutritional disorders. I. "Rickets in Pigs", by Elliot, Crichton and Orr (18), Rowett Institute. They state; "It is probable that the presence of a sufficient amount of an essential inorganic constituent need not prevent rickets. To ensure normal growth and health there must be not only a sufficiency of each of the essential inorganic constituents, but the ratio of these to each other must be adjusted to the needs of the animal.

"The influence of fat-soluble A can be briefly discussed. It is obvious that an abundance or relative deficiency of it need not necessarily prevent or produce rickets.———On the other hand the well-recognized value of codliver oil compared with linseed oil or lard in maintaining health and promoting growth is shown even in the pig, which evidently is not so susceptible to deficiency of fat soluble A as the rat". This was written in 1921 before the antirachitic factor D had been separated from A.

In Experiments on "The Effect of irradiation and diet on calcium and phosphorus metabolism", at the Rowett Institute 1924, Henderson (19) finds that one hour's irradiation (carbon arc) daily of a pig for 24 days definitely increased the calcium and phosphorus retention as compared with a control animal kept in the dark.

"Following upon irradiation the calcium and phosphorus in the urine rose, actually and relatively to their excretion in the feces, suggesting an increased absorption from the gut or a decreased excretion". There was no extra increase in body weight, however, along with these results. This would indicate that a stimulus to calcium and phosphorus retention does not necessarily involve a stimulus to growth in general.

These results were obtained with a pig kept on a diet badly balanced with respect to phosphorus, calcium and magnesium. "In the irradiated pig on a well-balanced diet no tendency was observed for the urinary calcium and phosphorus to increase after irradiation".

It should be understood that in this review only some of the more important experiments have been dealt with. Much valuable work has been done which cannot be mentioned here. Results of any value have only been obtained after a great deal of careful work involving time, patience, and a high degree of technical skill.

Distribution of the Three Accessory Food Factors or Vitamins in the Commoner Foodstuffs.

Foodstuff	Fat soluble A, or antirachatic factor	Water soluble B antineuritic factor	C, antiscorbutic factor
Butter	3	0	
Cream		2	
Codliver oil	3	0	
Mutton fat	2		
Beef fat, (suet) ..	2		
Lard, olive oil ..	0		
Cotton seed oil ..	0		
Herring oil	2		
Liver	2	2	1
Kidney, Heart ..	2	2	1
Brain	1	2	
Fish roe	1	2	
Milk raw	2	1	1
Eggs (fresh)			
Eggs (dried)	2	3	
Wheat germ	2	3	
Wheat bran	2	2	
Linseed, millet ..	2	2	
Peas, lentils	2	2	
Germinated cereals	1	2	2
Cabbage, fresh ...	2	1	3
Swede, raw juice .			3
Lettuce	2	1	
Spinach	3	3	
Lemon Juice			3
Lime Juice		1	2
Orange Juice	1	2	3
Nuts	1	2	
Yeast, dried			
Yeast, extract		3	0

This list of vitamin-containing foods is taken from a more lengthy table in Sherman and Smith's text "The Vitamins" 1922. Vitamin D is here included with A as at that time these two had not been separated from each other. The figures, used instead of plus signs, merely give the approximate relative vitamin content of the foods given.

Figure 1 means vitamin is present.

Figure 2 means food is a good source of vitamin.

Figure 3 means food is an excellent source of vitamin.

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The Organization of the Horticultural Section of the C.S.T.A.

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A number of Horticulturists in Eastern Canada have, for some time past, felt the need of a Horticultural organisation that might function as an association through which the ideas of those engaged in research, experimental and field work, might be brought together for mutual benefit, as well as for the assistance of those engaged more intimately in educational work.

The officers of the Horticultural Staff at the Central Experimental Farm undertook to obtain expressions of opinion from those most likely to be interested in such an organization, and the summary of these replies, emphasized the need of such an association, but expressed a wide variation in its scope and general formation.

As the Annual Convention of the C.S.T.A. was to be held in Ottawa it was deemed advisable to delay the preliminary work of or-

ganization until that time, so that horticulturists from Western Canada also, might have an opportunity of expressing their views in connection with such an organization.

A meeting was called of all horticulturists attending the C.S.T.A. Convention. At this meeting many valuable suggestions were made, particularly by delegates from British Columbia and Manitoba. The discussion again emphasized the need of a society particularly interested in horticultural work. The ideas expressed by those present, however, indicated a diversity of opinion as to the extent of the field to be covered. It was finally decided that owing to the growth of the C.S.T.A., in both membership and prestige, this organization was now on a parity, in its own field, with that of the larger American Association for the Advancement of Science; the time was ripe for forming within this Society, sections similar to those within the American Association, embracing members interested in a particular field of work. This decision was further strengthened when it was known that similar organizations of other sections were then being formed within the Society.

An organizing committee was then nominated, consisting of a Chairman and Secretary, together with the General Secretary of the Society, with power to add to this Committee when dealing with matters of organization.

The following resolution was then drafted and copies forwarded to the General Secretary of the Society and to the Resolutions Committee:—

"Whereas, we, the Horticultural members of the C.S.T.A., having felt the necessity of a channel of expression for matters relating to our particular work, have resolved that we ask the Dominion Executive to consider the formation of a Horticultural Section of this Society". Signed,

W. T. Macoun, Chairman.
A. J. Logsdail, Secretary.

The Chairman of this section, Mr. W. T. Macoun, Dominion Horticulturist, Central Experimental Farm, Ottawa, and the writer, as temporary secretary, express the wish of those present, that all horticultural members of the C.S.T.A. identify themselves as intimately interested in the development of this section by offering suggestions regarding the horticultural program to be undertaken. There are many phases of particular interest in the broad field of Horticulture, and there are men specially fitted to present many of these problems in a most interesting manner, to members of this section, either by articles in *Scientific Agriculture*, the magazine of the Society and for the Society, and periodically it may be possible to obtain personal contact with such men as lecturers to this section. The writer highly appreciates the opportunity afforded in this latter connection during the recent conference in Ottawa.

In concluding this brief outline of circumstances leading up to the development of a Horticultural Section, the writer sincerely regrets that he has not at hand the complete list of all those present at this initial meeting, and for any omissions that may occur in the following list of names of those present, he asks the kind indulgence of those so omitted, and will undertake to see that means for recording permanently the minutes of future meetings, are suitably supplied.

The following were present at this meeting: Prof. A. F. Barss, University of British Columbia; Prof. F. W. Brodrick, Manitoba Agricultural College; Prof. W. S. Blair, Experimental Station, Kentville, N.S.; Prof. F. E. Buck, University of British Columbia; Prof. T. G. Bunting, Macdonald College, Que.; Mr. M. B. Davis, Experimental Farm, Ottawa; Mr. A. J. Logsdail, Agricultural School, Kemptville, Ont.; Mr. W. T. Macoun, Dominion Horticulturist, Ottawa; Mr. E. F. Palmer, Horticultural Experiment Station, Vineland, Ont.; Mr. T. F. Ritchie, Experimental Farm, Ottawa; Mr. W. J. Tawse, Macdonald College, Que.

Conceptions rècentes en matière de classification des sols.

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Dans le numéro du mois de mars de cette revue, a paru un article très intéressant, sous la signature de A. H. Joel, professeur en Science des Sols, de l'Université de Saskatchewan, Saskatoon, intitulé: "*Changing view points and methods in soil classification.*"

Rappelons que l'auteur déclarait au début de son travail que les systèmes actuels de classification sont inadéquats. Ils sont basés, dit-il, principalement sur certains facteurs de modification extérieure tels que: lo L'origine géologique et 2o les influences climatériques et végétatives.

Or, si l'origine géologique donne de bons résultats dans l'étude de terrains locaux, il n'en est plus de même lorsqu'on compare des groupes de terrains de même origine géologique, mais fort éloignés les uns des autres, parce que des différences de climat peuvent leur imprimer des caractères absolument dissemblables. Ainsi un sol d'origine glaciaire dans la province de Québec pourra être différent d'un sol dérivé de matériaux morainiques semblables dans la Saskatchewan parce que son évolution aura été tout autre sous le climat humide du Québec que sous le climat semi-aride de certaines parties de la Saskatchewan.

Le facteur climat, continue l'auteur, s'est montré plus effectif lorsqu'on établit de larges groupements, mais il constitue un pauvre critérium de classification si on en fait usage pour des divisions locales. De plus, il y a beaucoup de variations qui ne peuvent pas être mises au compte du climat.

Aussi, monsieur A. H. Joel nous explique que le comité international établi à cet effet a choisi comme base de classification l'étude du profil du sol, dans lequel il est tenu compte de divers facteurs, pour remplacer les autres systèmes trouvés inadéquats.

Ce que l'on entend par profil du sol.

Nous résumons ici la description, que donnait l'auteur, du profil tel que le conçoit le comité international.

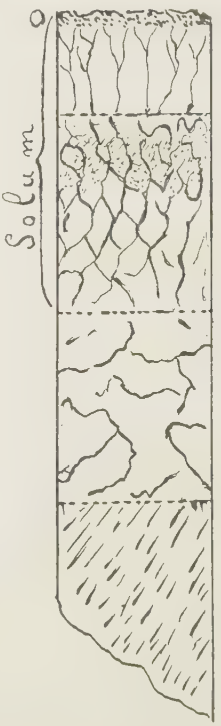
On entend par profil la section verticale jusqu'à un point pénétrant à l'intérieur des matériaux originaux non modifiés dont dérive le sol naturellement décomposé.

Dans le profil de tous les sols normalement formés, on distingue plusieurs couches appelés *horizons* qui représentent le produit final des différents facteurs intervenant dans la formation du sol, tels que: lo facteurs climatériques; 2o facteurs géologiques; 3o facteurs végétatifs, etc.

On observe généralement quatre couches principales dans le profil naturel d'un sol normal, qui, de haut en bas, sont:

1o Une couche d'épaisseur variable formée de débris organiques, indiquée par OM.

2o Une zône d'extraction ou de délavage, appelée horizon A.



HORIZON A— zône de délavage.

HORIZON B— zône d'accumulation.

HORIZON C— matériaux originaux, peu ou pas modifiés.

ROCHE MÈRE— matériaux non modifiés.

Schéma du profil d'un sol normal.

3o Une zône de concentration ou d'accumulation, dite horizon B.

4o La zône des matériaux originaux pas ou peu modifiés, appelée horizon C.

La couche superficielle de débris organiques, les horizons A et B constitueront le sol proprement dit, appelé *Solum*, par le comité international de classification des sols, terme proposé par le Dr. B. Frosterus de Helsingfors, Finlande.

A remarquer aussi que dans la plupart des sols, les horizons A, B et C présentent des subdivisions basées sur des différences de texture, structure, couleur, etc. Ainsi on aura les horizonsA^1, A^2, B^1, B^2, C^1 et C^2.

Or, l'évolution d'un profil de solum sera très différente suivant la nature du climat, sec ou humide, chaud, modéré ou froid. C'est ainsi que l'on peut déjà distinguer deux grands groupes de sols dans le monde.

1o Les sols des régions à climat plus ou moins sec, caractérisés principalement par la présence d'une zône ou horizon d'accumulation de $CaCO_3$ et de sels alcalins provenant du délavage des couches supérieures.

2o Les sols des régions à climat humide. Ici les précipitations atmosphériques sont assez abondantes pour produire une infiltration ou percolation continue de l'eau contenant les sels minéraux en dissolution. Les profils de ces sols se distinguent par l'absence d'un horizon de déposition de $CaCO_3$ et autres sels.

Dans ces sols les particules fines ont aussi une tendance à être entrainées mécaniquement par l'eau, de l'horizon A dans l'horizon B.

Travaux effectués en Europe.

Nous avons très brièvement indiqué le principe de la classification des sols par l'étude des profils, en résumant l'excellent exposé du professeur A. H. Joel, qui indique comme sources principales de ses informations les travaux du Dr. C. F. Marbut, *Chief of the Division of Soil Survey of the U.S. Bureau of Soils*, et différents écrits présentés à des conférences de l'American Soil Survey Association. Ensuite le professeur Joel continue son travail par des applications de ce principe à la classification ds sols de la Saskatchewan.

Disons maintenant que depuis quelques années il s'est fait aussi des travaux considérables en matière de classification des sols en Europe, à la suite de 2ème congrès agrogéologique international tenu à Stockholm en 1910, qui institua un comité pour traiter de la nomenclature et de la classification des sols du nord de l'Europe.

Ces travaux furent interrompus par la guerre mondiale qui empêcha toute collaboration entre les savants des divers pays belligérants.

Reprises activement après le retour de la paix, ces études ont fait l'objet d'un mémoire publié par la quatrième commission, "*Commission pour la nomenclature et la classification des sols,*" du Comité international de Pédologie, sous la direction du professeur Dr. B. Frosterus, de Helsingfors (Finlande) et édité en cette ville. Ce recueil de mémoires comporte les exposés de spécialistes en la matière, des pays suivants:

Allemagne, Autriche, Danemark, Egypte, Finlande, France, Grande-Bretagne, Hongrie, Irlande, Norvège, Pays-Bas, Pologne, Roumanie, Russie, Suéde et Tchéco-Slovaquie.

Ils sont imprimés en l'une des trois langues: française, allemande ou anglaise.

Parmi les plus intéressants et les plus originaux, basés précisément sur les conceptions récentes en ce qui concerne la formation et la classification des sols, il y a certainement lieu de mentionner ceux du Dr. B. Frosterus, chef de la section agrogéologique de Finlande; du professeur D. C. Glinka, de Pétrograd; du professeur B. Aarnio, de Helsingfors également; du professeur H. Stremme, de Dantzig, représentant l'Allemagne et la Finlande.

Aussi nous avons cru qu'il serait intéressant pour les agronomes qui tiennent à suivre un peu le développement scientifique dans le domaine de l'agrogéologie, de résumer ou traduire en un ensemble les principaux points traités dans les mémoires que présentent les savants dont nous venons de mentionner les noms. Pour ceux qui habitent la province de Québec, ces travaux présentent peut-être un intérèt d'autant plus grand que les régions auxquelles ont affaire ces agrogéologues de l'école russo-finlandaise offrent souvent des analogies remarquables avec celle que nous habitons. Ainsi, au point de vue géologique, la *Fenno-Scandia*, appelée aussi parfois *Bouclier Fenno-Scandinave*, région physiographique qui embrasse tout le territoire de la Suède, Norvège et de la Finlande, relève des mêmes formations précambriennes que notre grande

région du Bouclier Canadien. Comme ce dernier territoire, il a subi intensément les effets de la glaciation, à l'ère Pléistocène, qui en a fait un plateau semé de milliers de lacs, devant offrir de grandes ressemblances avec notre Plateau Laurentien.

D'autre part, les conditions climatériques de la Finlande et des parties adjacentes de la Russie et de la Suède sont très analogues aussi; climat plutôt humide, température moyenne de l'année, à Pétrograd, égale à celle de la ville de Québec.

Idées générales sur l'évolution et la classification des sols.

Le professeur C. D. Glinka, chef de l'école russe, considère le climat comme facteur fondamental de formation et de la classification des sols. (2)

"Il importe peu, dit-il, qu'un sol dérive d'un granite, d'une diorite ou d'une diabase. Les recherches prouvent que sous l'influence de conditions extérieures analogues, toutes les roches donnent naissance à des sols uniformes, tandis qu'une même espèce de granite fournira des sols très différents sous l'influence de conditions extérieures différentes.

Les principales propriétés des sols naissent dans le processus même de la formation. Ces propriétés sont dues à la modification des matières organiques d'un côte, à la désagrégation des minéraux de l'autre, et au transport des produits finaux dans les couches successives du sol."

Cette réaction contre la tendance ancienne de vouloir trop exclusivement tenir compte du facteur géologique dans la classification des sols, pousse peut-être le savant russe un peu loin dans la direction opposée, au cours de sa première affirmation.

S'il est vrai, comme il dit, que toutes les roches finissent par donner des sols uniformes sous l'influence de conditions extérieures (climatériques surtout) analogues, il y a cependant lieu de tenir compte que nous avons le plus souvent l'occasion de considérer les sols en voie d'évolution, à un point quelconque de leur cycle, et non pas tant au terme de celui-ci.

Dans ces conditions, il nous parait que l'origine géologique demeure un facteur fort important de classification, ce que semble d'ailleurs reconnaitre implicitement le professeur Glinka, dans des développements ultérieurs, tandis que le Dr. B. Frosterus le déclare explicitement lorsqu'il dit, en un endroit de son mémoire (3):

"Ce sont les conditions climatériques présidant à sa formation qui déterminent en premier lieu type du *solum;* le caractère de celui-ci est cependant conditionné par les propriétés des matériaux spécifiques *(Bodenart)* dont il forme une partie."

Traduisons encore, à la page 151 du même travail: "Le type du solum nous explique les approvisionnements de matériaux nutritifs renfermés dans le sol et indique les agents climatériques et géologiques qui furent en action dans la formation de la partie supérieure du sol."

Autre remarque de Miklazewski (4):

"Le sens de la décomposition de la roche-mère d'un sol sous l'influence du climat est stable. ce qui permet de grouper ensemble les sols d'un même territoire climatérique; cependant les sols provenant de différentes roches-mères ne sont pas toujours identiques. Ils diffèrent tantôt peu, tantôt beaucoup."

B. Aarnio, de Helsinfors et le Dr. H. Stremme, de Dantzig (Allemagne) dans le mémoire No. 7 intitulé: "*Zur Frage der Bodenbildung und Klassifikation*" (Concernant la question de la formation et de la classification des sols (5), adoptent aussi comme facteurs principaux: 1o Le climat; 2o les eaux souterraines; 3o le sous-sol (Bodenart), c.à.d. la nature géologique.

En tenant compte de ces facteurs, ils arrivent à classifier les sols d'après les types chimiques qui caractérisent leur profil et aboutissent à peu près aux mêmes résultats que Glinka et Frostérus.

Leur point de départ est le déplacement auquel les substantes dissoutes par le processus de formation ont été exposées dans le profil du sol.

Voici la traduction des principales considérations émises à ce sujet: "La formation des sols est caractérisée par le degré d'altération et le transport des produits d'altération. Suivant la manière dont les différentes substances solubles se déplacent et se déposent dans les différents horizons du sol, les différents types de celui-ci prennent naissance.

Les substances séparées se comportent différemment en l'occurence: les sels alcalins solubles dans l'eau sont les plus mobiles, les combinaisons d'alcalino-terreux, les sesquioxydes et les acides siliciques le sont moins.

La mobilité des substances humiques dépend des conditions de l'horizon du sol considéré; si celui-ci est pauvre en électrolytes, les matières humiques seront solubles dans l'eau, et si, inverséement, l'horizon du sol est riche en électrolytes (bases) les matières humiques seront coagulées et se dissolveront peu ou presque pas dans l'eau. C'est le climat (rapport entre la quantité de précipitation atmosphérique et l'évaporation) qui règle le mouvement de l'eau dans le sol. Par ce mouvement, les substances dissoutes sont délavées des couches supérieures du sol ou bien elles s'y accumulent. Si le mouvement de l'eau s'effectue, en ordre principal, de haut en bas, ou aura des sols délavés (podsol, latérite).

Si, au contraire, les précipitations atmosphériques sont si faibles que l'air est non saturé d'humidité et que la solution du sol tend énergiquement à remonter, il se formera, suivant le degré d'évaporation, des sols à croute (Krustenboden) ou des sols salins."

Entre les deux extrêmes, on rencontrera différents types intermédiaires, parmi lesquels on peut mentionner, par exemple, le "*tschernosem*" ou terre noire des steppes, dont il sera question plus loin dans le tableau de classification, et qui représente un état d'équilibre dans lequel on ne constate qu'un très faible déplacement des matières minérales.

La formation du sol, continuent les auteurs cités, peut cependant encore dépendre d'autres facteurs, et notamment, outre la nature du sous-sol, des eaux souterraines.

Ainsi on peut renconteer des sols salins sous des climats humides, lorsque le niveau de l'eau souterraine est élevé et que des solutions salines remontent par capillarité jusqu'à la surface pour y cristalliser. D'autres fois, ces eaux souterraines déposeront dans l'horizon du *solum* des oxydes de fer, formant alors une couche dure ocreuse, désignée sous la dénomination russe de "*glei,*" de "*ortstein,*" en allemand, "*alios,*" en français, et dont nous reparlerons aussi plus loin.

Le sol règne des composés mutabiles

(par le Prof. C. D. Glinka)

Dans un exposé assez technique, établissant bien les relations profondes qu'il y a entre la minéralogie et la science des sols, le professeur Glinka nous dit ce qui est actuellement connu relativement aux multiples transformations des minéraux silicatés, dans le sol. Ce exposé démontre amplement que les minéraux constitutifs des sols n'ont pas de composition constante, et c'est pourquoi Fersman leur a donné le nom de "mutabiles."

Jugeons-en plutôt par les considérations suivantes, que nous transcrivons:

"La désagrégation des silicates n'est en somme qu'un processus hydrolytique qui s'accomplit progressivement. Entre le minéral frais et le produit final, il y a une série d'intermédiaires souvent cristallins. Le processus s'observe le mieux chez les micas, qui subissent des modifications successives jusqu'à la kaolinite, et tous les produits intermédiaires ont un caractère cristallin évident.

Mes analyses de micas ont nettement démontré que le métal de la base est graduellement remplacé par l'hydrogène, ils se transformant en sels acides et laissent comme résidu l'acide libre qui est de la kaolinite. Dans les produits de désagrégation de la biotite, on trouve, outre du kaolin, du quartz qui se forme à la suite de la décomposition du groupe de l'olivine qui se trouve, d'après Vernadsky, dans la chaine latérale de la biotite, dont la composition peut être représentée par la formule:

$$(KH)_2\ (AlFe)_2\ Si_2O_8\ (MgFe)\ SiO_4$$

La muscovite laisse comme produit final du kaolin (sans quartz) ce qui permet de distinguer les paillettes kaoliniques provenant de la muscovite de celles qui proviennent de la biotite. La désagrégation des autres silicates alumineux qui sont des sels du groupe des acides micacés s'opère suivant le même principe.

Tels sont les silicates des groupes de la néphéline, de l'épidote, de la leucite, etc. Les minéraux qui contiennent simultanément des silicates alumineux avec le groupe micacé et des silicates alumineux avec le groupe chloritoide fournissent d'autres produits en se désagrégeant. Tels sont les pyroxènes et les amphiboles alumineux qui forment des mélanges isomorphes de trois groupes:

1o Le groupe métasilicate $R\ Si\ O_3$.
2o Le groupe du silicate alumineux avec le groupe micacé.
3o Le groupe chloritoide ou silicate de Tschermak.

L'argile, produit final des ces minéraux, diffère visiblement du kaolin, par sa consti-

tution, ses propriétés optiques et par sa couleur gris verdâtre. Elle porte le nom d'anauxite, (acide libre), on trouve de même une suite de sels acides intermédiaires.

En ce qui concerne le groupe des chlorites qui sont, d'après Vernadsky, des sels de l'acide chloritique, la question des produits finaux de désagrégation n'est pas encore bien connue. On ne peut douter cependant qu'ils ne se transforment en argile.

Les silicates qui ne contiennent pas de groupes d'oxydes du type R_2O_3 sont des sels des acides siliciques, le plus fréquemment des ortho et des métasilicates. En s'altérant ils forment des sels de plus en plus acides (serpentine, talc, etc.) et finalement ils laissent comme résidu l'anhydride silicique SiO_2.

Les zéolites donnent comme produit final de désagrégation la halloysite."

Si on est assez renseigné concernant les phases de la décomposition des silicates, on ne connait que peu de chose relativement aux produits intermédiaires de la décomposition des débris organiques, mais il est certain qu'ils forment un groupe de composés encore moins stables que les constituants minéraux du sol. Ces quelques considérations justifient donc bien l'appellation de "règne des composés mutabiles" appliquée au sol par Glinka, et que nous avons fait figurer en titre de ce paragraphe.

"l'altération des espèces minérales, comme la décomposition des matières organiques, se produit avec une intensité variable suivant les conditions climatériques, ce qui explique que les produits d'altération ne soient pas similaires dans les zônes à climats différents."

Ainsi, dans les régions tropicales humides, où règne une température élevée, l'argile elle-même se décompose, il s'en sépare de l'alumine. Il y a alors formation de latérite, type curieux de sol, auquel nous reviendrons plus loin.

De là aussi, d'après Glinka, la formation de plusieurs types de sols, constituant des unités fondamentales dans leur classification, d'après la variation dans la nature des produits d'altération des minéraux et de l'humus.

Principaux types de sols communs aux classifications de Glinka, de Frostérus et de Aarnio et Stremme.

Quoiqu'il y ait certaines variantes dans la base de classification adoptée par chacun de ces auteurs, ainsi qu'on l'a vu, au point de vue essentiel elle est à peu près la même, puisqu'ils prennent, tous, les conditions climatériques comme facteur principal, en tenant nécessairement aussi compte du facteur géologique ou pétrographique ainsi que de certains autres agents pour aboutir à la classification suivant les profils.

D'après cela, on peut distinguer surtout deux grandes catégories des sols ainsi qu'il a été dit dans l'introduction de ce travail:

A Les sols des régions à climat humide.
B Les sols des régions à climat aride.

Entre les extrêmes de chacune de ces deux catégories, on trouvera toute une gradation de types intermédiaires. C'est ainsi que G. Wiegner (*Boden und Bödenbildung*), 1918, donne l'échelle suivante des types:

1o Sols arides à l'extrême.
2o Sols arides.
3o Sols semi-arides.
4o Sols semi-hunides.
5o Sols humides.
6o Sols extrêmement humides.

De plus, nous verrons que certains types de sols peuvent relever soit d'un climat plus ou moins aride, soit de conditions humides. Ce sont donc des sols aclimatiques, qu'on pourrait placer dans une catégorie C.

1o Latérites.

Représentent un type de sols absolument caractéristiques des conditions du climat chaud et humide, rencontrées sous les tropiques. Quoique d'un faible intérèt au point de vue pratique, pour nous qui sommes plutôt voisins des régions boréales, les latérites offrent un phénomène très curieux à étudier.

Nos connaissances relativement à la formation des sols dans les pays tropicaux et subtropicaux, dit Glinka, sont encore très incomplètes, mais on sait que l'énergie de la décomposition des matières organiques y est très intense; le sol retient peu l'humus qui, n'étant pas saturé de bases aborbées, passe facilement en solution colloidal.

D'autre part, l'altération des silicates alumineux est poussée à l'extrême et ne laisse comme résidu que des oxydes d'alumine hydratés, à l'état libre; il y a aussi accumulation d'oxydes de fer et de manganèse hydratés, de même que de l'acide titanique.

Les bases alcalines et alcalino-terreuses, de même que la silice des silicates sont énergiquement lessivées.

PROFIT DU SOL A DIABASE, BOUGOUROU, GUINEE

LATERITE

Horizons	Pourcentage en poids calculé sur le sol séché à l'air			Pourcentage en poids calculé sur les substances minérales		
	Croute superficielle	Latérite poreuse, audessus de la diabase	Diabase non décomposée	Croute superficielle	Latérite poreuse, audessus de la diabase	Diabase non décomposée
Quartz	1.4	0.96	—	2.06	1.25	—
SiO_2	1.3	5.83	51.37	1.91	7.56	51.37
Al_2O_3	60.19	37.03	12.36	88.52	48.04	12.38
Fe_2O_3	3.91	31.73	3.29	5.75	41.17	3.29
Fe O	—	—	6.16	—	—	6.17
TiO_2	1.03	1.29	0.70	1.51	1.67	0.70
CaO	0.17	0.19	10.66	0.25	0.25	10.68
MgO	—	—	13.26	—	0.06	13.29
Na_2O	—	—	1.60	—	—	1.60
K_2O	—	—	0.41	—	—	0.41
H_2O	32	23.02	0.40	—	—	—

D'après A. Lacroix.

Suivant Aarnio et Stremme, la température élevée transforme les oxydes de fer en variétés rouges et détermine la teinte rouge-brique qui est si caractéristique pour la latérite.

Ce qui frappe surtout dans l'examen d'un certain nombre de tableaux d'analyses chimiques de latérites, reproduit par les auteurs précédents, d'après A. Lacroix (*Les latérites de la Guinée et les produits d'altération qui leur sont associés*—Nouvelles archives du Muséum, 5ème série, Paris, 1914), c'est la proportion énorme de Al_2O_3 qu'elles renferment. A titre d'exemple, donnons le tableau de composition au dessus.

Comme on le voit, les latérites, ou certains horizons de ces sols du moins, représentent de véritables minerais d'aluminium. H. Stremme fait d'ailleurs remarquer que les gisements de bauxite (minerai d'aluminium) trouvés au Vogelsberg, dans la province de Hesse, doivent être considérés comme des sols de latérite fossile. On peut y observer un profil complet de latérite, avec tous ses horizons caractéristiques, dit-il.

Dans le type latérite, Glinka distingue plusieurs variétés, suivant l'atténuation des caractères propres; c'est ainsi qu'on aura:

a/ *Les latérites-sols*, possédant les caractères typiques au degré maximum;

b/ *Les Terres rouges*, dans les régions subtropicales, caractères déjà atténués;

c/ *La Terra-rossa*, trouvée sous les latitudes climat chaud, mais déjà tempéré;

d/ *Les Terres jaunes*, rencontrées, p.e., dan le sud de la France, forment la transitio entre les latérites et les podsols des con trées tempérées et humides.

2o Le type Podsol.

Est propre aux régions humides dont l'a est relativement humide, et où les solution du sol se déplacent principalement de hau en bas. Les horizons supérieurs, A1, et A du *solum* sont lessivés, tandis que les sub stances dissoutes se déposent plus ou moin dans l'horizon B sousjacent (B. Aarnio et H Stremme). Par "*podsol normal*", on enten un profil dans lequel s'observe, en dessous d la couche humifère, une zône décolorée, à la quelle fait suite un horizon d'enrichissemen couleur de rouille, qui, plus bas, passe a sous-sol non modifié (B. Frostérus). De l aussi le terme de "terres rouillées" *(Roster den)* appliqué communément aux podsols. L couche décolorée s'observe surtout bien dan les terres sablonneuses. L'horizon A2 es ordinairement lessivé, blanc ou gris-blan (couleur cendre de bois) et d'une épaisseu variant entre quelques millimètres et 10 centi métres (Aarnio et Stremme). La teinte d l'horizon B varie du jaune au brun foncé.

La décomposition des matières organique y est moins active que dans les latérites l'humus s'accumule en quantités considér

ables, mais, n'étant pas saturé par des bases, il passe facilement à l'état de *sol* (solution colloidale). Ces sols d'humus agissant comme colloides préservateurs entrainent dans les profondeurs les particules limoneuses (oxydes ferriques et oxydes de fer colloidaux). En se coagulant, les sols d'humus, simultanément avec les sesquioxydes de fer, d'aluminium et de manganèse hydratés, peut former des couches d'alios (Ortstein, en allemand), dont il sera encore question plus loin (C. D. Glinka).

Il résulte aussi de ce processus d'évolution, que les couches superficielles acquièrent une texture plus grossière et s'enrichissent en silice, tandis que les couches sous-jacentes, où se déposent les matières entrainées, deviennent visqueuses et compactes (Glinka).

La désagrégation des silicates s'arrête au terme des silicates alumineux acides; il ne se forme, parait-il, que des quantités minimes d'agile.

Ces sols sont ordinairement plus ou moins pauvres en électrolytes et éléments nutritifs pour les plantes.

Les différents agrogéologues distinguent un assez grand nombre de variétés du type podsol. Pour ne mentionner que les principales, d'après Aarnio et Stremme, citons:

a/ *Les podsols ferrugineux;*
b/ *Les podsols humiques;*
c/ *Les sols gris de forêt;*
d/ *Les sols bruns de forêt.*

A l'état primitif, les podsols sont essentiellement des terres couvertes d'une végétation forestière; Glinka distingue cependant aussi des podsols de prairie. La plupart des sols de la province de Québec sont plus ou moins "*podsolés*", et relèvent donc du type podsol; il est facile d'observer les caractères spécifiques de ce type de terrain dans les tranchées faites à l'occasion de l'établissement de chemins, du creusement d'excavations, etc., dans certains terrains sablonneux surtout; l'horizon A^2, constitué de sable décoloré, blanc ou gris-cendré, tranche fortement sur l'horizon A^1, formé de sable humifère, qui lui est superposé, et l'horizon B^1, ou zône de concentration, qui se distingue par sa couleur d'un brun-rougeatre, résultant de l'accumulation de la limonite, $2\ Fe_2O_3.\ 3\ H_2O$.

Cependant, il nous semble bien que nos terres grises, constituées d'argiles Champlain ne sont que très faiblement podsolées; on n'y observe guère d'horizon de lessivage distinct. Elles se classeraient probablement parmi les sols gris de forêt.

(suite au prochain numéro)

NOUVELLES DE NOS MEMBRES

Nous apprenons que monsieur Rosario Proulx, B.S.A., assistant-agronome dans le comté de Missisquoi, a été nommé assistant-régisseur de la Ferme expérimentale fédérale de Ste. Anne de la Pocatière.

Monsieur Alvarez St. Denis, B.S.A., de la dernière promotion, 1926, de l'Institut Agricole d'Oka, vient d'être désigné comme assistant de l'ami Ferdinand Larose, agronome officiel des comtés de Russell et Prescott, Ontario.

Nous sommes encore informés que monsieur J. Michaud, B.S.A., de la dernière promotion du Collège d'Agriculture de Ste. Anne de la Pocatière, a été nommé à la direction du cours d'enseignement de la nouvelle école d'agriculture moyenne de Rimouski, qui vient d'ouvrir ses portes le 16 septembre dernier.

Monsieur Amédée Filion, agronome officiel à Maniwaki, est transféré, au même titre, à Sorel, poste nouveau crée pour le comté de Richelieu.

Monsieur Marcel Bonnier, sous-agronome à Ste. Thérèse, a remplacé monsieur Amédée Filion à Maniwaki, comté de Hull.

Monsieur Paul Omer Roy, B.S.A. de la dernière promotion à l'Institut agricole d'Oka, est nommé assistant-agronome de Monsieur Lucien Therrien, à Bedford, comté de Missisquoi.

Concerning the C.S.T.A.

Dr. G. C. Creelman, President of the Society, will meet the members of the Montreal local at a luncheon on October 2nd, and the members of the Quebec City local at a dinner on October 4th. Immediately after his return to his home at Beamsville, Dr. Creelman will launch a Dominion-wide membership campaign for the Society, in which he expects the full co-operation of every member.

The Alberta local is holding a dinner meeting at the Royal George Hotel, Edmonton, on Wednesday, October 13th. The speaker will be Mr. A. E. Ottewell, Director of Extension at the University of Alberta, and his subject "Canadian Tonic, 1926 Brand."

The Eastern Ontario local has arranged a regular series of events for the winter months, commencing with a dance at the Chateau Laurier, Ottawa, on October 29th.

NOTES

T. P. Devlin (Alberta '25) has resigned his position on the *Nor'-West Farmer* and is now Assistant Agricultural Agent of the Canadian National Railways at Winnipeg.

M. A. Watt (O.A.C. '25) is now teaching agriculture at Leamington, Ont. His address is P. O. Box 297.

W. H. Upshall (O.A.C. '23) is continuing his graduate studies this winter at the University of Maryland.

S. A. Hilton (O.A.C. '23) Asst. Superintendent of the Dominion Experimental Farm, Nappan, N.S., is taking graduate work at Cornell University.

W. A. DeLong (O.A.C. '20) has recently been appointed to the staff of the University of Minnesota, Division of Chemistry. His address is 1497 Chelmsford St., St. Paul, Minn.

E. P. Bradt (O.A.C. '12) has been appointed Director of the Boys' Training School, Bowmanville, Ont.

H. G. Oldfield (O.A.C. '20) has sold his farm at Inglewood, Ont., and is taking graduate work in Agricultural Economics at the University of Minnesota.

G. A. Richardson (O.A.C. '20) is teaching Dairy Chemistry and conducting research work in dairy products at the College of Agriculture, Davis, Cal., a branch of the University of California.

L. T. Chapman (O.A.C. '21) has just been appointed Associate Editor of the *Nor'-West Farmer*, Winnipeg. He was formerly Asst. Superintendent of the Dominion Experimental Station, Lacombe, Alta.

Jos. Ficht (Alberta '24) has been appointed to the staff of the School of Agriculture, Raymond, Alta.

P. Stewart (O.A.C. '14) Secretary of the Canadian Seed Growers' Association, was married in Victoria, B.C., on September 28th, to Muriel Grace Wilson of that city. D. G. Laird (O.A.C. '15) acted as best man. Mr. and Mrs. Stewart will take up residence in Ottawa about the end of October.

McCulloch's Book

Members of the C.S.T.A. should all read "The Men of Kildonan", the historical romance written by their fellow-member J. H. McCulloch (O.A.C. '16), and recently published in New York and Toronto. It is an absorbing story of the Selkirk settlers who, in the early part of the nineteenth century, came by hazardous routes to the Red River Valley of Manitoba. The book is extremely well written, is full of intensely interesting incidents and dramatic action, and its 300 pages have to be read at one sitting.

The list price of the book is $2.00 (Geo. H. Doran Company, New York; McClelland & Stewart, Toronto). Orders from C.S.T.A. members will be taken care of by the General Secretary through the Text Book Club.

Inheritance of Quantitative and Other Characters in a Barley Cross.*

K. W. NEATBY†

Dominion Rust Research Laboratory, Agricultural College, Winnipeg, Man.

The cultivated species of barley offer a wealth of material for genetic studies. Varieties differ in a great many readily distinguishable characters, and species hybridize readily. Previous studies on inheritance in barley have been confined largely to individual characters, but a few linkages have been demonstrated, and owing to the relatively small number of chromosomes the general tendency in work now in progress is to establish the linkage groups definitely.

This study was undertaken with the purpose of determining the inheritance of earliness, height, density of spike, and length of outer glumes. And in the hope of discovering one or more linkage groups, two morphological characters were also studied; namely, lateral floret fertility and adherence of the lemma and palea to the caryopsis.

REVIEW OF LITERATURE

A comprehensive survey of the literature on barley inheritance will not be included. Attention is drawn merely to previous work that has a direct bearing on this study.

Babcock and Clausen (1) discuss quantitative inheritance at some length. They make the statement that as more work is done on the problem, more evidence is supplied in support of the multiple factor hypothesis.

Florell (5) studied the inheritance of earliness in a cross between Sunset (early) and Marquis (late) wheats. He obtained results in F_2 that indicated a single factor difference for time of maturity. Earliness was dominant to lateness.

A study was made, Caporn (2), of 106 F_3 families of a cross between an early and a late variety of oats. Ripening notes were taken on individual plants. It was not possible to divide the families into homozygous and heterozygous classes; nearly all had a wide range of variability. He suggests a 3-factor explanation.

In the barley cross Svanhals x Lion, Griffee (6) made a study of the inheritance of earliness. Maturity notes were taken at heading time on 135 F_3 families. These fell into three very distinct groups: homozygous early, heterozygous, and homozygous late in approximately a 1 : 2 : 1 ratio. An interesting feature of this work is the demonstration of linkage between a quantitative and a botanical character. Earliness was shown to be linked with the six-row condition. The linkage intensity was quite low, there being 42 percent cross-over. Resistance *Helminthosporium sativum* was found to be definitely associated with three independently inherited characters; two-rowed lines were more resistant than six-rowed, lines with white glumes showed more resistance than lines with black glumes, and rough awned lines were more resistant than smooth awned. It was concluded that at least three independantly inherited factors must be concerned in the inheritance of resistance to *Helminthosporium sativum*.

The work of Engledow (4) and other investigators (10, 11) indicates that the four species of barley as classified by Harlan (7) constitute a series of multiple allelomorphs.

Hayes and Harlan (9) studied the inheritance of density in a number of barley crosses. The F_1 plants were either dense or intermediate. Studies in F_2 and later generations indicated that in some cases the inheritance of density could be explained on a single main factor basis. In other cases it was necessary to assume the presence of two or more factors

* A thesis submitted to the Faculty of Agriculture, University of Saskatchewan, in part fulfilment of the requirements for the M.S.A. degree.

†Formerly Graduate Assistant in the Field Husbandry Department, University of Saskatchewan, now Cerealist at the Dominion Rust Research Laboratory, Winnipeg.

The study was made under the direction of Dr. J. B. Harrington, Assistant Professor of Field Husbandry, University of Saskatchewan. The writer gratefully acknowledges his helpful criticism. Dr. C. H. Goulden, Cereal Specialist, Dominion Rust Research Laboratory, kindly assisted in preparing the material for publication. The seed for the F_2 population was supplied by Professor Weiner of the Manitoba Agricultural College.

TABLE I. Degree of difference between parent varieties considering lateral floret fertility, naked or covered seed, earliness, height, density, and length of outer glume.

Name	Lateral florets	Naked or covered seed	Number of days from June 20 to heading	Height in inches	Length of 12 intenodes of rachis (mm.)	Length of oute glume (
Guy Mayle	six-rowed	naked	6.620±.107	28.480±.117	38.450±.154	20.500
Canadian Thorpe	two-rowed	covered	13.608±.098	36.594±.141	28.326±.162	9.925
Difference			6.988±.145	8.114±.184	10.124±.224	10.575

to explain the results. Griffee (6) cites the results of Ubisch, which showed a single main factor difference for dense versus lax; minor factors, also, were assumed to influence spike density.

In a cross between barley varieties with naked and covered seed, Hor (11) found the inheritance of this character to be governed by a single factor; covered seed was dominant to naked seed. Gaines and Thatcher, according to Hayes and Garber (10), working independently, found the naked condition to behave as a simple recessive to the covered.

Since this investigation was completed, Hans and Olaf Tedin (13) have published the results of some inheritance studies in barley. Their results clearly indicate a linkage between the two-rowed condition and tallness.

MATERIAL AND METHODS

Parental Forms

The varieties used in the cross were Guy Mayle and Canadian Thorpe; the former being used as the female parent. Guy Mayle is a six-rowed, hulless, early, short, lax and has long outer glumes. Canadian Thorpe is two-rowed, hulled, late, tall, dense, and has short outer glumes. Both varieties were uniform for the characters mentioned. Table I contains data showing the extent to which the varieties differed in the characters studied.

The cross was made at the Manitoba Agricultural college by Professor Weiner. The F_1 generation was grown at the same institution, so that the writer had no opportunity of making observations on it. This was not a serious omission, as in a study of quantitative characters, a condition that obtains one year cannot fairly be compared with that obtaining in another. It would have been desirable to have grown a small F_1 population along with the F_2.

F_2 Generation

In 1925 the F_2 generation was grown at th University of Saskatchewan. The seed wa planted three inches apart in rows five fe long. In every ten rows one row of each pa ent was included. The planting was all don on the same day.

At harvest four spikes, when as many we obtainable, were cut from each plant, an placed in envelopes for storing. Later th data for each plant were recorded on numbe ed cards. Details of the methods employed i making the various measurements are give below in the sections devoted to individu characters.

INHERITANCE OF CHARACTERS CON SIDERED INDEPENDENTLY.

Lateral Floret Fertility

The F_2 plants fell into three main grou on the basis of lateral floret fertility. Tab II shows an excess of the two-rowed form and a corresponding deficiency of interme iates. The ratio of six-rowed to other typ is almost exactly in the proportion of 1 : The intermediate plants ranged from tho with almost complete lateral floret fertili to those in which only one fertile later floret was developed. A number of plan classified as two-rowed had well develope though sterile laterals. It is probable, ther fore, that a number of genetically intermedia plants were classified as two-rowed. A sing main factor difference between two-rowed ar six-rowed is indicated, but owing to the di ficulty of making a clear cut separation b tween the three types it would seem reaso able to assume that there are probably or or more minor factors capable of modifyir the degree of fertility in the intermedia group. The data contained in Table III ter to support this view.

TABLE II. F_2 plants of the cross Guy Mayle x Canadian Thorpe classified according to fertility of lateral florets.

	Six-rowed	Intermediate	Two-rowed	Total
Obtained	501	944	563	2008
Expected	502	1004	502	2008

$X^2 = 109.98$

TABLE III. Distribution of intermediate F_2 plants in the cross Guy Mayle x Canadian Thorpe according to lateral floret fertility.

Number of fertile laterals	1–3	4–6	7–9	10–12	13–15	16–18	19–21	22–24	25–27	28–30	31–33	34–36	37–39	40–42	43–45	46–48	49–51	52–54	55–57	58–60	61–63
Number of plants	248	98	52	44	44	29	38	29	33	45	34	37	48	66	30	36	19	9	4	1	0

Hulled and Naked Seed

Of the 2008 plants classified, 1483 were hulled, and 525 were hulless. The deviation from a 3 : 1 ratio divided by the probable error*, gives odds (Pearl and Miner (12)) of 3.45 : 1 against the deviation being a result of random sampling. This is not a significant deviation; it may be expected to occur 22 times in 100. These results are in agreement with the results of previous workers. (See 'Review of Literature' above.).

Earliness

The index of maturity used was the emergence of the awns of the earliest spike. Florell (5) has shown that the time for heading and the time of ripening are closely associated in wheat; this is probably true for barley and other cereals also. Florell also points out that the development of a plant is less subject to delay or acceleration due to climatic conditions, at heading time than at ripening time. Disease probably often modifies the rate of development at ripening time. Furthermore, it is much simpler to determine when awns have emerged from the sheath than it is to decide exactly when a plant is ripe. In the present case the entire population, including checks, was examined daily during the heading period. Dated tags were fastened to the plants when the awns first emerged. These tags were placed in the envelopes with the spikes when the latter were harvested. Records of 1893 F_2 plants were obtained. Figure 1 shows the distribution of F_2 plants together with the parental distribution. The means are as follows: Guy Mayle 6.620 ± 0.107, Canadian Thorpe 13.608 ± 0.098, and the F_2 population 8.77 ± 0.034. The distribution is distinctly unimodal. It is obvious, therefore, that no conclusions concerning the genetic factors involved can be drawn without making a study of subsequent generations. It appears that early maturing is partially dominant to late maturing.

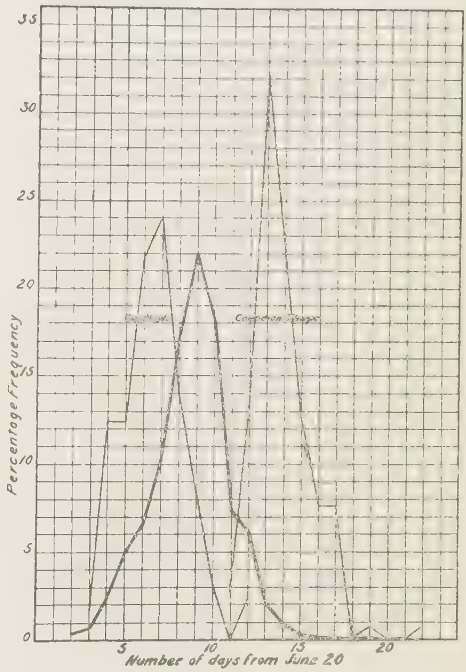


Figure 1. Distribution of F_2 plants in the cross Guy Mayle x Canadian Thorpe, by the number of days from June 20 to date of awn emergence.

*Probable error $= .6745\sqrt{.25 \times .75 \times 2008}$

Height of Plant

The height of the plants was taken at ripening time, and recorded on the reverse side of the tags used for the heading record. Height was taken on about half the population only, 1012 plants. The form of the curve shown in Figure 2 suggests that the measuring of a larger number would not have been worth while. The distribution appears to be quite normal. There is no tendency to division into groups in spite of the fact that there was a difference of over eight inches between the parental heights. The mean heights are: Guy Mayle 28.480 ± 0.118, Canadian Thorpe 36.594 ± 0.141, and the F_2 population 33.920 ± 0.057. Again F_3 data are necessary before conclusions can be drawn with regard to the genetic factors concerned. It appears that tallness is at least partially dominant.

Density of Spike

The variation in density from the lower to the upper part of the spike was found to be very small in the parent varieties. In the F_2 population, however, it was observed that some spikes became progressively more lax towards the apex, while others became more dense. Furthermore, some variation in density from spike to spike on a single plant was evident, though with few exceptions it was very small. In order to avoid, as far as possible, error due to these variations, two spikes from each plant were used, the twelve internodes nearest the centre of each spike measured, and the mean of the two measurements in millimetres recorded.

As previously stated, no data concerning th F_1 generation is available. Figure 3 shows the distribution of the F_2 plants and the parents. The means are: Guy Mayle 38.45 ± 0.154, Canadian Thorpe 28.33 ± 0.163, and the F_2 plants 33.23 ± 0.060. It is quite obvious that there is no dominance, the F_2 mean being approximately midway between the parental means. It is probable that the parents carry different factors for density, as there is an indication of transgressive segregation. It is interesting to note that Hayes and Harlan (9) in density studies conducted with five different hybrid populations, in no case obtained any evidence of transgressive segregation. In most cases the extremes of the F_2 distributions fell at, or just beyond, the modal classes of the parents.

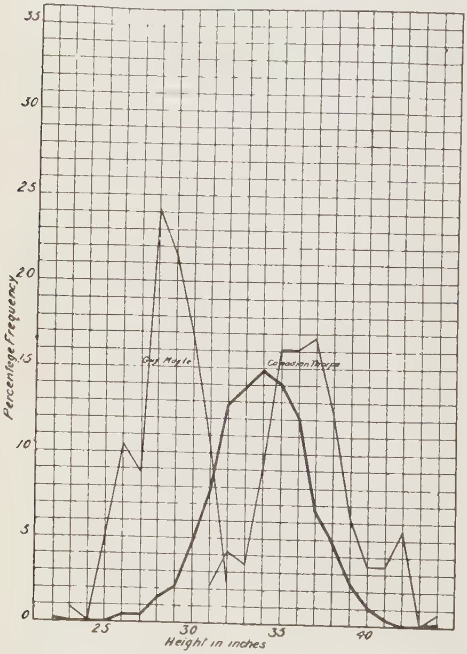


Figure 2. Distribution of F_2 plants in the cross Guy Mayle x Canadian Thorpe by height of plant.

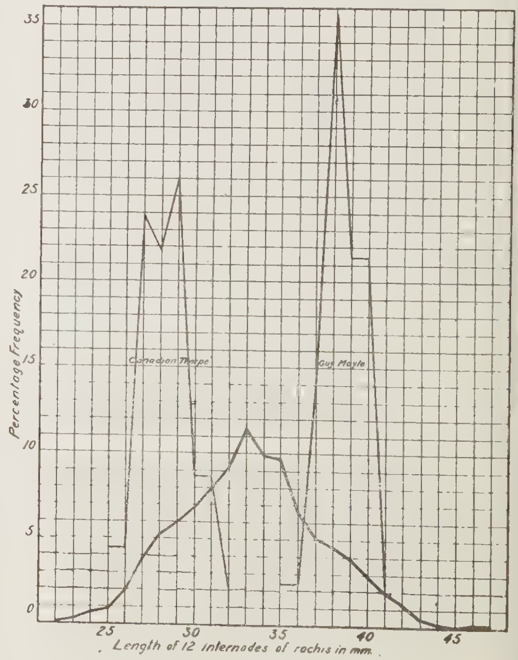


Figure 3. Distribution of F_2 plants in the cross Guy Mayle x Canadian Thorpe according to density of spike.

Length of Outer Glume

The writer has failed to find any account of studies on the inheritance of outer glume length in barley.

Before taking any data on the hybrid material, a preliminary study was made with a view to determining the variability of outer glume length on individual spikes. One glume was taken from the lower, middle, and upper parts of 50 spikes of each parent variety; all glumes were taken from a median row of florets. It was found that glume length was very uniform on the lower and middle part of the spike, but towards the apex a slight shortening was evident.

On the hybrid material one glume was taken from each of two spikes of every plant. Glumes were always selected from median florets near the middle part of the spike, and removed with forceps for measuring. The average of the two measurements was recorded for each plant.

It appears from Figure 4 that long is almost completely dominant to short. A glance at the figure shows that the F_2 population is divided into two main groups. If the curve is divided at class 14 half of that class being allotted to the 'shorts', and half to the 'longs', a ratio of 1553 long to 429 short is obtained. The deviation from a 3 : 1 ratio divided by the probable error, gives odds (Pearl and Miner (12)) of 3138 : 1 against the deviation being a result of random sampling.

The number of plants in each of the four main groups illustrated in Figure 5 are as follows: hulled long 1072, hulled short 395, hulless long 481, and hulless short 34. According to the X^2 method of determining goodness of fit, the deviation from a 9 : 3 : 3 : 1 ratio is highly significant. A value of 265 is obtained for X^2. This also supports the view that outer glume length cannot be dependent on a single factor in this cross.

Before discarding the single factor explanation, it is well to consider the possibility of a linkage with the factor for hulled seed. By assuming such a linkage, a cross-over percentage of 34.06 is obtained. (Emerson (3)). But the goodness of fit test gives a value of 18 for X^2. $(P = .0004)$. Again the value for

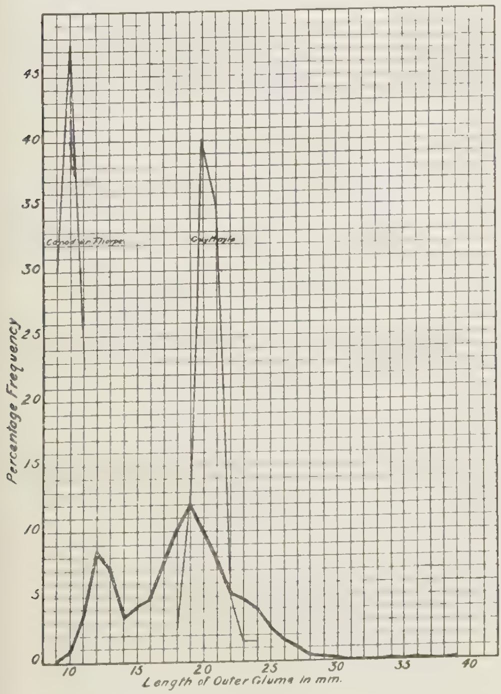


Figure 4. Distribution of F_2 plants in the cross Guy Mayle x Canadian Thorpe, according to length of outer glume.

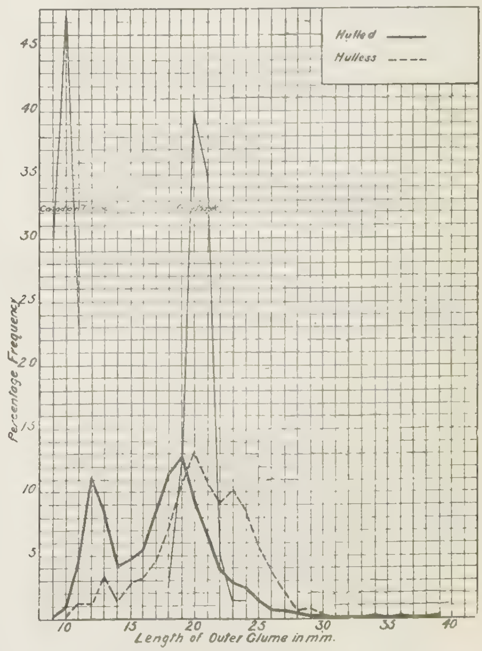


Figure 5. Distribution of F_2 plants, divided into hulled and hulless classes, according to outer glume length.

TABLE IV. Plants grouped acording to outer glume length and adherence, or non-adherence, of the chaff in the cross Guy Mayle x Canadian Thorpe.

F_2 genotype		Number of Plants	
		Actual	Expected
H H L L L′ L′ H H L L l′ l′	Hulled long	1072	1116
H H l l l′ l′ H H l l L′ L′	Hulled short	395	372
h h L L L′ L′ h h L L l′ l′ h h l l L′ L′	Hulless long	481	465
h h l l l′ l′	Hulless short	34	31

X^2 is too high, and it appears that this explanation is not satisfactory.

If it is assumed that two factors are concerned in the lengthening of outer glumes, one of which is incapable of expression in the presence of the factor for hulled seed, a very good fit is obtained.

Table IV gives the suggested genetic constitution, together with the actual and expected ratios. The symbols used are as follows: H and h for hulled and hulless, L the main factor for outer glume length, and L′ the factor that is expressed only in hulless plants. It is clear from the figures given in Table IV, and also from the frequency distributions, that H, L, and L′ are almost completely dominant. It is, therefore, unnecessary to consider the heterozygous combinations as, for example, plants actually constituted H H L l L′ l′ fall into the H H L L L L′ group. According to the X^2 method, P = .2615; thus there are 26 chances in 100 of a deviation as large as this occurring as a result of random sampling. It is interesting to note that this is a better fit than is obtained when the characters hulled and hulless are considered alone. (See page 79).

LINKAGE RELATIONS

The data presented below show a definite association of maturity, height, and density with lateral floret fertility. Table V contains the means for the two-rowed and six-rowed groups, together with their differences. The ratio of the difference to the probable error indicates that the differences, though not large, are highly significant. It will be observed (Figures 6 to 8) that in each case the two- and six-rowed curves are not widely separated.

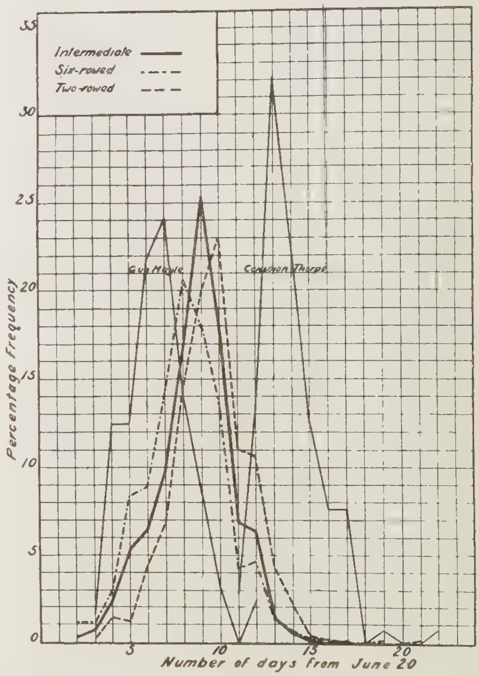


Figure 6. The cross Guy Mayle x Canadian Thorpe, F_2 generation. Frequency distributions of the different lateral floret classes according to date of awn emergence.

TABLE V. Showing the degree to which the two- and six-rowed groups differ with respect to maturity, height, and density in the cross Guy Mayle x Canadian Thorpe.

	Six-rowed	Two-rowed	Difference	P.E./Diff.
Maturity	8.117±.073	9.58±.062	1.463±.096	15.2
Height	32.640±.104	34.58±.110	1.940±.151	12.0
Density	34.890±.113	32.12±.112	2.771±159	17.4

In other words, none of these quantitative characters are very closely linked with the two- or six-rowed condition. This is what would be expected. We have shown that lateral floret fertility is governed by a single main factor difference. We have also shown that each of the quantitative characters studied are almost certainly depended upon two or more independently inherited factors. It is clear, therefore, that the linkage could not be very intense.

SUMMARY

Cultivated species of barley, acording to Griffee (6) have only seven pairs of chromosomes. This makes barley a suitable crop for linkage studies.

Guy Mayle and Canadian Thorpe differ widely in earliness, height, density, and outer glume length. The former variety is six-rowed and hulless, and the latter two-rowed and hulled. The inheritance of each of these characters was studied.

Time of maturity, height, and density are probably dependent on two or more independently inherited factors. Outer glume length is dependent upon two factors, one of which is not expressed in the presence of the factor for hulled seed.

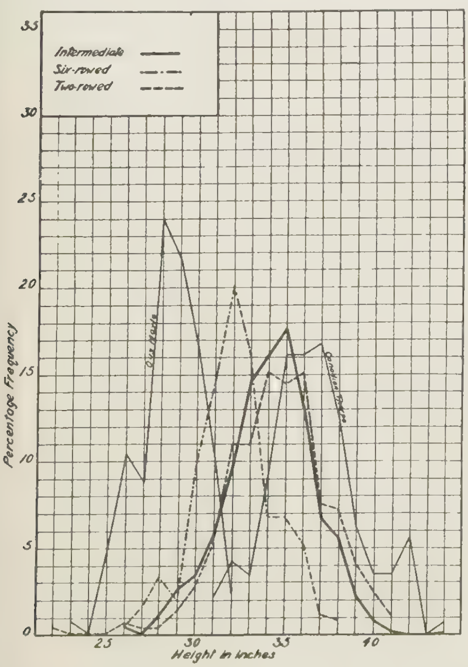


Figure 7. The cross Guy Mayle x Canadian Thorpe, F_2 generation. Frequency distributions of the different lateral floret classes according to height of plant.

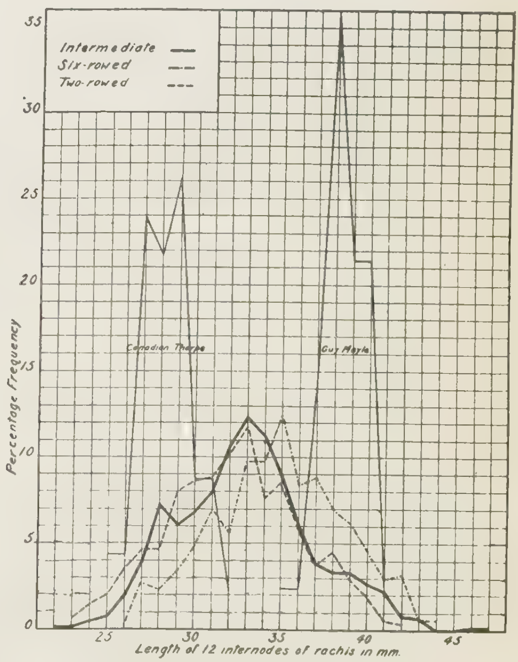


Figure 8. The cross Guy Mayle x Canadian Thorpe, F_2 generation. Frequency distributions of the different lateral floret classes according to density of spike.

There is a single main factor difference between two-rowed and six-rowed varieties. The hulless condition behaves as a simple recessive to the hulled condition.

The three quantitative characters, maturity, height, and density are all linked with lateral floret fertility. Two-rowed forms tend to be late, tall, and dense; while six-rowed forms tend to be the reverse.

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Time Table for Canadian Record of Performance 303-day Test.

Table to facilitate the computing of the dates involved in R.O.P. test work.

Arranged by

E. W. CRAMPTON

Macdonald College, P.Q.

With the increasing numbers of cows now being put onto Record of Performance test, the problem of computing the several dates involved in each individual case has come to require a considerable amount of time on the part of those responsible for test animals. With an idea of making easier this task the following table has been prepared. In it, using the dates in Col. 1, as calving dates or dates of beginning of test, are given the dates marking the terminations of the 305-day milking period (Col. 2) and the 400-day calving limit (Col. 3). Col. 4 gives the last date on which a cow may be re-bred to calve within 400 days of her last calf, and in the last column will be found the date the cow is due to calve where Col. 1 is used to indicate the date of breeding.

Example: A cow calving on March 10th and starting her record then would finish her 305-day milking period on January 8th, and would have to calve again on or before April 13th, to fulfil the conditions of the test. As shown in column 4, in order to calve by April 13th, it would be necessary to breed her not later than July 6th, of her record year.

Date of last calf.	End of 305-day Milking Period.	End of 400-day Calving Limit.	Last date cow can be bred to calve within 400 days of previous calving.	Date due to calve (using column 1 as breeding dates).	Date of last calf.	End of 305-day Milking Period.	End of 400-day Calving Limit.	Last date cow can be bred to calve within 400 days of previous calving.	Date due to calve (using column 1 as breeding dates).
Jan. 1	Nov. 1	Feb. 4	Apr. 29	Oct. 8	July 1	May 1	Aug. 4	Oct. 27	Apr. 8
5	5	8	May 3	12	5	5	8	31	12
10	10	13	8	17	10	10	13	Nov. 5	17
15	15	18	13	22	15	15	18	10	22
20	20	23	18	27	20	20	23	15	27
25	25	28	23	Nov. 1	25	25	28	20	May 2
Feb. 1	Dec. 2	Mar. 7	30	8	Aug. 1	June 1	Sept. 4	27	9
5	6	11	June 3	12	5	5	8	Dec. 1	13
10	11	16	8	17	10	10	13	6	18
15	16	21	13	22	15	15	18	11	23
20	21	26	18	27	20	20	23	16	28
25	26	31	23	Dec. 2	25	25	28	21	June 2
Mar. 1	30	Apr. 4	27	7	Sept. 1	July 2	Oct. 5	28	9
5	Jan. 3	8	July 1	11	5	6	9	Jan. 2	13
10	8	13	6	16	10	11	14	7	18
15	13	18	11	21	15	16	19	12	23
20	18	32	16	26	20	21	24	17	28
25	23	28	21	31	25	26	29	22	July 3
Apr. 1	30	May 5	28	Jan. 7	Oct. 1	Aug. 1	Nov. 4	28	9
5	Feb. 3	9	Aug. 1	11	5	5	8	Feb. 1	13
10	8	14	6	16	10	10	13	6	18
15	13	19	11	21	15	15	18	11	23
20	18	24	16	26	20	20	23	16	28
25	23	29	21	31	25	25	28	21	Aug. 2
May 1	Mar. 1	June 14	27	Feb. 6	Nov. 1	Sept. 1	Dec. 5	28	9
5	5	8	31	10	5	5	9	Mar. 3	13
10	10	13	Sept. 5	15	10	10	14	8	18
15	15	18	10	20	15	15	19	13	23
20	20	23	15	25	20	20	24	18	28
25	25	28	20	Mar. 2	25	25	29	23	Sept. 2
June 1	Apr. 1	July 5	27	9	Dec. 1	Oct. 1	Jan. 4	29	8
5	5	9	Oct. 1	13	5	5	8	Apr. 2	12
10	10	14	6	18	10	10	13	9	17
15	15	19	11	23	15	15	18	12	22
20	20	24	16	28	20	20	23	17	27
25	25	29	21	Apr. 2	25	25	28	22	Oct. 2

The Relation of the Red-backed Cutworm to Diversified Agriculture in Western Canada.

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At the recent meeting at Saskatoon of the Western Canadian Society of Agronomy one of the delegates, a prominent farmer, made the statement to the writers that, in his opinion, cutworms were the limiting factor in the development of sweet clover in his district. This is but a concise re-statement of numerous reports, both verbal and written, which have been received from a large part of the province during the past two years. More detailed observations have also led the writers to conclude that the damage done by the red-backed cutworm (*Euxoa ochrogaster* Gn.) seriously retards the introduction of diversified farming on the prairies. With these facts in mind this article has been written to create a wider appreciation of the importance, both immediate and potential, of the red-backed cutworm as affecting prairie agriculture, and to point out that practical remedies exist. By so doing it is hoped to promote an even fuller cooperation between the farmer, the agronomist and the entomologist.

The Present Trend of Diversification

While it is not within the scope of this paper to enter into a detailed discussion of this vital problem of western agriculture, a brief analysis of its more important phases is essential to a proper understanding of the relation in which the red-backed cutworm stands to the development of diversification of crops.

The researches of Shutt (1) at Indian Head afford ample basis for the statement made by Russell (2) that the one-crop system of agriculture as practised on the Canadian prairies and elsewhere, namely, a cereal crop alternating with summer-fallow, is, of all methods ever devised and used by man, the most wasteful of the elements of soil fertility. Agronomists have not been unmindful of this fact, and the efforts of the leaders of agriculture in Western Canada have been directed towards securing diversification of crops, to escape from this wasteful "cereal mining". That real progress is being made is evidenced by the fact that in Saskatchewan (3) crops other than spring-sown cereals made up 10% of t total area in crop in 1924, as compared wi only 4% in 1916. The more essential featur of the advance have been , (a) the introdu tion of suitable crop rotation, (b) the d velopment of a legume adapted for wid spread use under northern prairie cond tions, (c) the substitution, for an increasi proportion of the summer-fallow, of intertil ed crops, such as sunflowers and corn, an recently, grain in rows, and (d) the increa of stock-raising and dairying. The crops i volved are hardy biennial sweet clover, a falfa (chiefly in irrigated districts), flax,** sunflowers, corn, some of the cultivated gras es, and fall rye.

The Red-backed Cutworm† Materially Affects this Programme

With the exception of the grasses and fa rye, all of the above crops are more su ceptible to cutworm damage than are t spring-sown small grains. Furthermore t growing of any intertilled crop, as well as t use of summer-fallow, has, on account of t cultural practices involved, a very defin effect in increasing the probability of c worm damage the following year.

The red-backed cutworms are almost om vorous, their ravages extending to all sprin sown crops, while during outbreaks they m also cause very severe damage to such woo plants as second year sweet clover. Togeth with this diversity of food there is a no worthy difference in the degree of damage the various plants attacked, to the detrim

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* The writers wish to express their appreciation to L. E. Kirk, Professor of Field Husbandry at the Univer of Saskatchewan, for reviewing this paper, especially th portions relating to agronomy.

** Flax, although not an essential crop in the rotat is a useful one, affording a cash crop which may seeded fairly late if necessary, and a crop suitable for in fields heavily infested by wireworms; recently, a mixt of wheat and flax has been advocated.

† The habits, life-history and present methods of con of the red-backed cutworm are described in a re pamphlet (4) which may be obtained from the Departm of Agriculture, Ottawa, or from the Dominion Entomol cal Laboratories at Treesbank, Man., Saskatoon, Sask., Lethbridge, Alta.

of the popularity of those crops, (except grasses), which it is desired to introduce on the prairies in diversified agriculture. The reason for this is threefold. The broad-leaved plants are much preferred as food, even in the presence of young cereals, the crops listed possess, if cut while young, no powers of recovery and, it takes many seedlings of flax or sweet clover to satisfy the appetite of a cutworm, thus more than counterbalancing the effect of the greater number of plants per acre. The relatively much smaller number of plants of intertilled crops is also a point of importance.

In support of the statements made above two reports, involving two types of evidence, are given below.

During the summer of 1925 the opportunity was afforded the authors to make detailed observations on an infested field of fifty acres on the farm of the University of Saskatchewan. During 1924 this field was in sunflowers, in 1925 it was seeded, May 2 to 4, with a mixture of fifteen pounds of sweet clover, three pecks of wheat and five pounds of rye grass per acre. Early in June it was noticed that while there was a fair stand of grain there was very little sweet clover to be seen, notwithstanding the fact that the weather was very favourable to germination. On June 9th, a careful examination of the field was undertaken to determine the cause of the deficiency.

In this examination small representative sample plots of soil were taken from 30 locations in the field. Each of these was selected as typical of the area in which it was taken, and its general location was determined by systematic sampling of the whole area. A plot consisted of a space one foot long and six inches wide with a drill row running through the centre in the long axis. Each lot of soil was subjected to a careful examination, covering the number of uninjured plants, the number of cut plants which would not recover and the number of cut plants which would recover in each of the three crops. In addition the number of cutworms in each sample was recorded. The figures for the wheat and cutworms are given below, these representing the average per square foot:

Wheat plants cut but recovering	1.
Wheat plants destroyed by cutworms	0.4
Healthy wheat seedlings	7.
Cutworms	1.8

The figures for sweet clover cannot be given accurately on account of the difficulty in many cases of differentiating between the cut stems of weed and sweet clover seedlings. From the observations, however, it is safe to say that at this date at least 60% of the sweet clover had been cut off by cutworms while the final loss was in the neighborhood of 90%. The figures on the rye grass are also rather indefinite but from the examination recorded and from subsequent observation we estimate that the loss did not exceed 15%. The wheat, in spite of the low rate of seeding, yielded thirty-one and a half bushels per acre, owing largely to the heavy stooling following the exceptionally favourable moisture conditions of June.

From these and many other observations it was clear that, in a year such as 1925, when ample soil moisture ensures nearly perfect germination of properly scarified seed, poor stands of first year sweet clover result almost invariably from the work of cutworms, even in fields where very few cutworms can be found by the average layman and where the nurse crop shows few or no signs of damage. A realization of the truth of this is important since, in 1925, many undoubted instances of the kind were attributed by farmers to other or to unknown causes.

The injury to sweet clover in its second spring is of importance in relation to apparent winter-killing. In one field in the Indian Head district, examined in 1925 by the senior author in conjunction with several agriculturists of the locality, more than half of the plants were destroyed and the growth of the remaining half greatly delayed by injury apparently caused entirely by cutworms. Until this examination this loss had been attributed to winter-killing. In this connection the possibility of disease should not be overlooked; the symptoms are, however, quite different from those described by Newton and Brown (5), since the cutworms attack the crowns and young shoots and the lower roots remain healthy, a complete reversal of the diseased conditions.

The examples cited show the very marked damage to sweet clover. This exists to an equal extent with flax or alfalfa when these are sown with a nurse crop; where these crops are sown without a nurse crop the damage tends to be even more serious. This assumes a greater importance in the instance of flax

because of a general mistaken tendency to use this crop for re-seeding after loss of the first crop by cutworms.

Sunflowers and corn do not suffer so severely, in spite of the smaller number of plants per acre, owing to the more robust nature of the seedlings and the much more limited period of attractiveness to cutworms. Partially severed plants often continue to grow but are almost invariably so stunted as to be of little value.

The differential rate of damage is again illustrated in the second item of detailed evidence against the red-backed cutworm, compiled from the records of a district. Through the courtesy of Mr. J. J. de Gryse of the Entomological Branch, estimates of the damage in the Indian Head district during 1925 were obtained from Mr. W. H. Gibson of the Experimental Station, from Mr. Norman Ross of the Forestry Station, and from Mr. D. McKaye. From these independent estimates the figures presented are compiled, holding near the more conservative figure for each crop. Expessed in percentage of the final yield, estimated as expected had not cutworm damage occurred, the loss was:

Wheat	4%
Barley and Oats	25%
Corn	30%
Sunflowers	50%
Sweet Clover, 2nd year	40%
Sweet Clover, 1st year	80%

Flax was not included in these estimates but, judging from our observations in other districts, it suffered a loss similar to that of seedling sweet clover. The relatively small damage to wheat as compared with oats and barley was due to other factors, such as date of seeding and nature of preceding crop, and should not be considered indicative of a greater susceptibility of the latter crops over the former.

Mention was made above of the effect of intertilled crops in favouring cutworm damage during the following year. This phase of the work requires further investigation, but evidence at hand indicates that the damage following this method of cultivation, particularly where corn or sunflowers are utilized, tends to be considerably higher than following other crops, and slightly higher than after summar-fallow. This is related to the shelter for moths provided by the standing crop, and to the incidental maintenance of a loose soil surface, which results from frequen cultivation and favours oviposition.

The investigation of this species has show that feeding by the moths is essential if ma ture and fertile eggs are to be deposited i appreciable numbers. Presumably, in natur the nectar of flowers is the only generall available food. There seems to be little doub that if an entire district were so intensivel planted to cereal crops that no flowers suit able to moths were available, there coul be there no outbreak of the red-backed cut worm. Be that as it may, the availability o flowers very attractive to the moths, a in fields of sweet-clover, alfalfa, or sun flowers, is a factor of great importance i increasing the probability of destructive in festation in neighbouring fields the next sea son. In some instances, availability of foo and shelter for the moths has served to ex plain what was otherwise apparently a purel fortuitous distribution of infestation in a given locality.

The Cutworm is a Recurrent Menace

In view of the potential importance, in any year, of the red-backed cutworm to diversified agriculture, the question naturally arises whe ther extensive damage in one season is likely to be followed by serious outbreaks year after year. The record of outbreaks in Western Canada does not definitely warrant such an assumption, but it does indicate that this cut worm will probably be a very serious periodic‡ menace, particularly in certain types of country. From such data as are available for Saskatchewan it is found that there were outbreaks of this pest centering around the years 1891, 1901, 1906, 1911, 1915, 1919 and 1925. The outbreaks in the other Prairie Provinces were approximately coincident with these. Except for the last twelve years the data are meagre for Saskatchewan, but in this period we find severe injury by this cutworm recorded in some locality for every year but three, as follows:

1914; Fairly general damage.
1915; Widespread outbreak.
1916; (No record, but probably considerable abundance).

‡ The factors causing this periodicity are not fully understood as yet, but the more important ones may be suggested:—Relative prevalence of disease and fluctuations in the abundance of natural enemies principally parasites, both of these being rather closely correlated with weather conditions, the former particularly with rainfall and temperature in May and June; influence of summer weather conditions on fecundity of the moths; and the effect of spring weather on the time of hatching.

1917; Northwest Saskatchewan.
1918; Prince Albert District.
1919; Rather important outbreak, fairly general.
1920; Purely localized.
1921; No damage recorded.
1922; No damage recorded.
1923; Some importance in north-eastern Saskatchewan.
1924; Important in central and north-eastern Saskatchewan; also in the Indian Head district.
1925; Very important outbreak; see map.

Thus the cutworm-free years of 1921 and 1922 were followed by increasing abundance and spread, possibly culminating in the outbreak of 1925 when the damage in Saskatchewan exceeded $4,000,000, a loss which would have been at least doubled except for a very fortunate combination of weather factors during June.

Areas Most Subject to Infestation

Fortunately, not all portions of the Prairie Provinces are equally liable to suffer serious loss. An examination of most of the records of outbreaks, together with our investigations, affords, ample evidence for a tentative conclusion that the red-backed cutworm is closely associated ecologically with cold temperate forest and savanna conditions. The forest may be deciduous as in parts of Eastern Canada, or mixed. The species ranges well beyond such plant formations, but virtually all records of its economic importance are for localities in which arable fields alternate with groves and clumps of trees or tall shrubs. The direct factors involved are not well un-

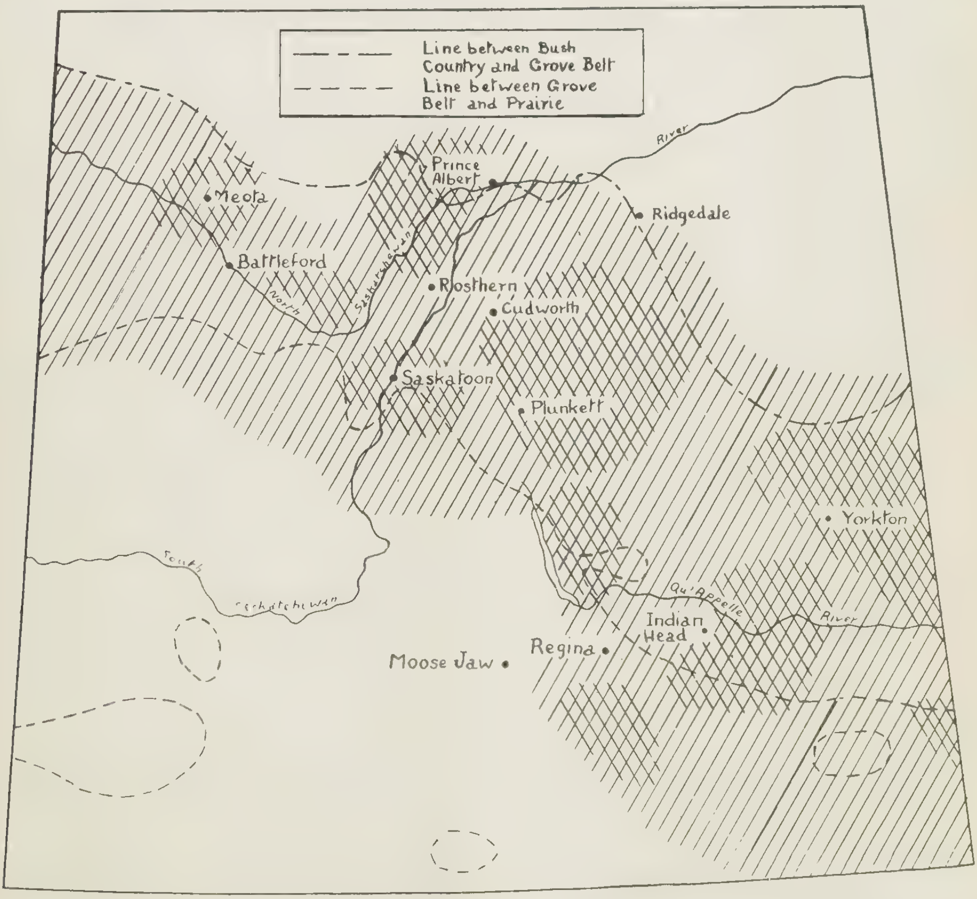

Figure 1. Map of the southern portion of the province of Saskatchewan showing the area infested by *E. ochrogaster* in 1925. Light shading represents a final reduction in yield of all crops of over one per cent. Heavy shading represents a final reduction of over four per cent.

derstood but the association is too well evidenced and too important to neglect.

The situation is well illustrated by conditions in Saskatchewan. The accompanying map shows this association for the season of 1925. The lines demarcating the limits of the poplar grove savanna * (grove belt) ** are taken from an official map (7), but reports of correspondents and our own observations indicate that, particularly in the south-east, the savanna extends considerably further south and west than the map shows. The estimates of cutworm damage are compiled from the reports of the crop-correspondents and district representatives of the Saskatchewan Department of Agriculture † and from our own observations. The close association between the area of savanna and that of important cutworm infestation in 1925 is very evident. That this association is not merely accidental is shown by the unpublished records, kindly made available to us by Mr. Norman Criddle of the Entomological Branch, covering the general outbreak of 1915, when approximately the same territory was involved, and also by the records already indicated for other years.

At present, in Saskatchewan, agriculture has not penetrated far into the northern coniferous forest (bush country), but where farming does occur in such areas there is evidenced an occurrence of cutworm outbreaks to the same extent as in the savanna. There are indications that, in several parts of the savanna belt, there occur limited localities in which the red-backed cutworm normally maintains itself during unfavourable periods, and from which the infestation spreads widely and rapidly under conditions favouring the species. At the crest of an outbreak, or in the years immediately following, damage often extends into the open prairie southwest of the savanna, especially into that belt‡ bordering it, where thickets of wolf-willow (*Elaeagnus commutata* Bernh.) and Snowberry (*Symphoricarpos occidentalis* Hook.) are numerous and extensive. There is available only one definite report of economic importance of this species beyond the belt of thickets.

* Nomenclature for the formations or biota follows Shelford, Jones and Dice (6), as these names are based on conditions both of plant and animal life considered together. The poplar grove savanna corresponds to the deciduous forest-grassland transition of Shreve.

** The names in parenthesis correspond to those used on the map (7); another local name is that of "park belt".

† The writers wish to express their great appreciation to Messrs. F. H. Auld, M.P. Tullis, R. W. Neely and others who extended this helpful co-operation.

‡ Scrub sub-climax formation of Clements.

Of the other Prairie Provinces, the greate part of Manitoba is included in the savann or forested areas, while in Alberta these for mations include little of the agricultura area in the south but most of that north o Red Deer. Thus we would anticipate only infrequent and relatively unimportant infestations by this species in southern Alberta and southwestern Saskatchewan, but rather frequent outbreaks, of varying intensity and area in the remainder of Saskatchewan, in Manitoba and probably in north-central Alberta. We expect also that as agriculture extends into the more northern districts of these provinces, particularly in Saskatchewan and northern Alberta (especially the Peace River district)), this cutworm will there prove an important pest, thus greatly increasing its range of economic significance.

The General Effect Upon Crop Diversification

From the foregoing analysis of the situation, the truth of the statement made at the beginning becomes at once evident, namely, that the red-backed cutworm is a very serious menace to the introduction of diversified agriculture in the Prairie Provinces. The direct loss to those crops specially subject to damage may be fairly readily estimated in any particular year, and is, of course, relatively not of very great importance, because of the comparatively small acreage involved at present. Of very much greater importance, however, is the indirect damage, the resultant postponement of the introduction and utilization of those crops which are now most necessary. All agriculturists are familiar with the fact that the average farmer, if induced to experiment with a new or unfamiliar crop, is easily discouraged by even a partial failure at the beginning. Thus, for example, if he loses a seeding of sweet clover by cutworms in one year he naturally hesitates before seeding the same crop the next year. Other farmers, noting his experience, are more hesitant of a similar departure from the well-known methods. In this way important infestation in any given district, even at intervals of three or four years, has a very marked deterrent effect. These considerations are very far from being theoretical. For example, one unusually progressive farmer known to the writers,—a man interested in dairying, and utilizing crop rotation, intertilled and leguminous crops, after two years

of cutworm damage had almost decided to abandon sweet clover, flax and corn. Thus, damage by the red-backed cutworm, in the several aspects already detailed, exerts a powerful pressure on farmers to continue in the old system.

How to Reduce the Cutworm Difficulty

It is not within the scope of this paper to detail methods for control of the red-backed cutworm. A rather thorough discussion is available in the publication (4) already mentioned. It is sufficient to state here that this cutworm can be economically and effectively controlled by a timely and proper used of a poisoned bran bait. Not only has this method been effectively employed by the writers under a variety of conditions, but we have authenticated reports of its successful use by practical farmers, without supervision, to control the cutworm in twenty to fifty acre fields of corn, sunflowers and flax, as well as cereals. There seems no doubt that the bait is a practical remedy, and that it should be widely used to meet the present situation.

What is now most needed is a realization of the danger, conviction as to the practicability of control measures, and dissemination of the knowledge concerning methods of control. It is in this direction that the agronomist can be of great service in meeting the problem which affects his work even more closely than that of the entomologist. In the ultimate analysis control of this pest depends very largely on the individual farmer, aided to a certain extent by organization.

At this point it may be well to note that, simultaneous with the stress being placed on immediate control measures, much attention is being paid to ways in which damage may be predicted, prevented or reduced in the future. One tentative conclusion of immediate importance may be mentioned; it is recommended that, wherever possible in cutworm districts, western rye grass be seeded with sweet clover (and the customary nurse crop) thus in many instances insuring a fair stand of a suitable hay-crop even when the sweet clover is destroyed by cutworms.

Summary

Damage by the red-backed cutworm depresses the growing of those crops which it is most desirable to introduce in the Prairie Provinces in an effort to promote diversified agriculture, and exerts a strong pressure tending towards a continuance of the straight grain farming now practised.

The principal crops which it is desired to introduce are sweet clover, alfalfa, flax, corn and sunflowers. The above crops suffer more severely than grain because they are preferred to cereals by the cutworms, because, if cut while young, they have no powers of recovery and because the seedlings, at least of the first three mentioned, are very small.

The growing of intertilled crops increases the probability of cutworm damage the following season. The abundance of suitable flowers of legumes and sunflowers has also an important influence in this direction.

General outbreaks of the red-backed cutworm occur in the Prairie Provinces at irregular intervals, seldom more than five years apart and usually extending with greater or less intensity over a period of several years.

The most serious damage generally develops in association with the savanna or grove belt but, particularly at the crest of an outbreak or in the years following, often extends considerably beyond this floral zone. As a result of this association, it is anticipated that the economic importance of this species of cutworm will increase as agriculture extends northward.

The economic control of the red-backed cutworm under farm conditions by the use of poisoned bait is practicable and the adoption of this practice by farmers, where circumstances make it advisable, is very greatly to be desired.

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An Investigation of Root Activity of Apple and Filberts, Especially During the Winter Months.

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Introductory Remarks

The work reported below was carried on at the Oregon Agricultural College under weather conditions very similar to those which prevailed in British Columbia's lower coastal sections during the winters of 1922-23 and 1923-24. Field observations checking up the same have been made also in British Columbia during the years 1924 and 1925 in all fruit growing sections of the Province, and such observations appear to substantiate those recorded in this paper.

Reason for the Investigation

The work here recorded opens up a vast field for investigation. Its importance is such as to necessitate its being carried on over a period of years, both under field and under carefully controlled conditions. It is a type of investigation which throws light on many unsolved physiological problems so vital to the commercial grower. For instance, the growth of roots during the winter months and their continued activity renders them (and incidentally the tree) very susceptible to freezes in the winter time and we could expect far more so-called winter injury in a climate such as this than in a climate where the winters are more severe and the ground remains completely frozen until the Spring time, and consequently the roots have to remain dormant.

Again, it is possible that the growing season here during mild winters must be of such a nature that in order for a tree to continue its normal development during the remainder of the year the roots must make a considerable portion of their growth during the winter months in order to attain the depth required and avail themselves of a large enough feeding area to cope with the heavy drain on them during the latter part of the season when moisture is scarce and little food available as a result. Hence, if the roots did not make this required growth during the winter months, but for some reason received a check for any length of time, the tree would suffer to a varied extent depending on the length of time growth did not take place. Many physiological disorders might be expected as a result.

Such being the case it would follow that in the dry mountain valleys of the west where the winters are severe and where the summers are hot and dry, very little growth is liable to take place during either of these periods. The growing season in the spring, therefore, must be of such a character that rapid growth of roots is assured because the same amount of growth must be made in the early spring months after frost gets out of the ground as is made here in the milder sections during both the winter and spring combined.

On the other hand, in the East, the roots while not growing in the winter, due to the severe temperatures, may nevertheless continue growth all summer long, due to summer rains and high relative humidity. Another factor which will be discussed and one which is constantly met with in this section, is that relating to the possibility of a high water table during the winter and spring.

Materials Used and Methods Employed

Nineteen observation posts were established under trees in the College orchard under different conditions. The observation posts consisted of specially constructed boxes with a rectangular section cut out of the bottom and a piece of glass held in place by wooden cleats around the hole. The glass could be easily lifted (in case of fogging) to make the observations and measurements. The depths of the sides of the boxes depended on the depth the box was to be planted, namely, 6, 10 or 12 inches,—in other words the depth at which the observations were to be made.

The soil was then removed from the portion of the root of the tree under observation, until a satisfactory root, or roots, was exposed at the required depth. The box was then placed horizontally over the root, or roots, in such a manner that the glass bottom was immediately over the exposed portion. (see Fig. 1). The soil was then replaced around the box and inside the box was placed a covering of first, a piece of felt paper, next a sack, and the remainder was stuffed with straw and a little soil. Thus the covering could be easily removed and the root exposed any time for examination.

Four of these boxes were established vertically by digging a trench to a depth of approximately two and one-half feet and placing the box sideways against the roots in such a manner that the glass bottom covered the roots desired for measurement. (see Fig. 2). Thus it was possible to obtain a vertical view of the roots at a depth of from one to two feet.

The soil was then replaced around the sides and on top of the box leaving the front open and sufficient of the ditch to get down into to make observations. As before, the glass was covered with felt paper and sacks, and the rest of the box and trench stuffed with straw.

Temperatures were recorded at these depths daily, and the height of the water table was recorded, tile having been inserted at these posts vertically.

In Plot 1, where posts were established, the ground was very low and the water table comes to the surface at some period every year, consequently these posts were established here primarily to note the effect of a high water table on root development.

In Plot 2, the posts were established on a piece of ground where the water table stays well below the surface in a normal year with the exception of one corner where two posts were established as a check on plot 1.

Any checking of root development here as contrasted to the low point mentioned, presumably would be the result of factors other than the water table.

Plot 3, the filbert plot, one section was high and well above the water table at any time, while the other section was low where the water table reaches the surface each year.

A check was kept each week by digging up samples of roots, taking them to the laboratory and washing them out and measuring new growth made. From two to three hundred samples were counted and measured each week and the average length taken. Here also notes on the water table and temperature were recorded.

Temperatures were recorded daily, the water table twice weekly and root measurement weekly, occasionally oftener.

Results of the Investigation 1922-23

On December 12th, the soil temperature reached 22 degrees at 6 inch depth.

In plot 1, the water table came up near the surface, submerging the roots at 10 inch depth on December 2nd, and they remained submerged until January 20th.

FIGURE 1
SHOWING THE OBSERVATION BOX IN HORIZONTAL POS

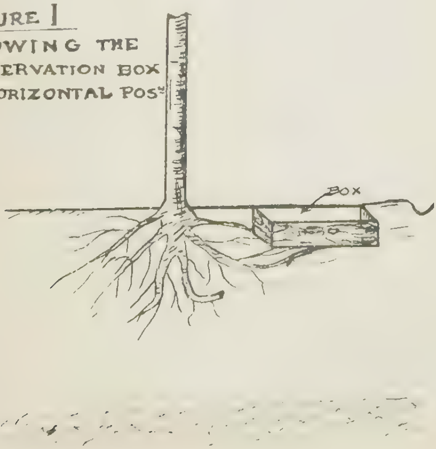
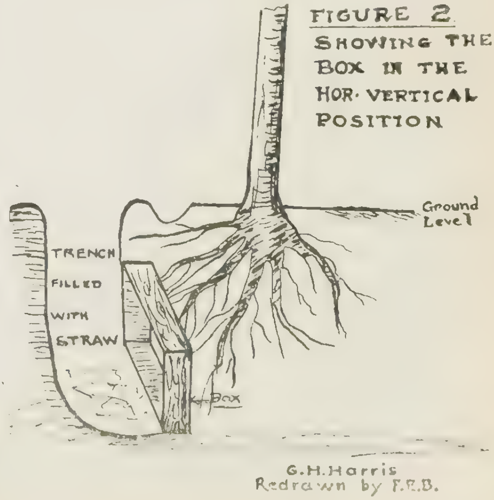


FIGURE 2
SHOWING THE BOX IN THE HOR. VERTICAL POSITION



Roots at the 6 inch depth in this plot were submerged on December 5th until January 13th.

Root growth ceased about this time December 10th—14th, and did not start again until around February 8th, or approximately two months later.

So here was a case of submergence closely followed by a severe freeze.

In plot II, on the higher ground, the roots at the depth under observation were not submerged at any time so any check would be due to frost only.

Root growth here stopped about the same time as the same depths in plot 1. However, by January 9th, they were starting out again, approximately a month sooner than those subjected to submergence and freezing.

A very interesting feature was here recorded, namely, in the change in the appearance of the root. The new rootlets while in a growing stage are very white and watery in appearance. Those that were submerged while stopping growth just before or at the time the severe temperature arrived remained unchanged in appearance and were caught in this stage by the frost.

However, those which were not submerged, just previously to the low temperature, apparently began to lose water, shrivel in thickness and take on a hard brown skin. Thus, when the freezing temperatures hit them they were in a protected stage and did not suffer like the submerged ones. So it would appear that if rootlets are not to suffer severe injury during a freeze they must be in this protective brown stage.

In the submerged areas only the larger roots survived; the smaller ones turned black and died. The browned ones, wherever favorable conditions arose, commenced growth either by starting to extend their tip, sending out side shoots, or both.

In Plot 3, the results corroborated those of Plot 2 and Plot 1, namely growth checked by low temperature commenced growth more readily than the roots that ceased growth due to submergence, and far more readily than those that had been checked by submergence plus freezing, this latter cause being very detrimental.

A soil temperature of 22 degrees F. was severe enough not only to retard growth but also to check it for a considerable period, whereas a soil temperature of 29 degrees I merely holds growth or retards it unless sul jected to freezing over a long period and starts immediately conditions become favou able again. Where there was no submergenc and temperature conditions were favourabl growth took place all winter long.

Roots submerged for a short time do n necessarily become checked immediately, pr vided the soil is in good physical conditio and well aerated, and provided also that th rise of the water table which is caused b excessive rains, can drain off and the wate does not stand long.

The work was continued during the winte of 1923-24. The work was begun a littl earlier and three phases of the experimen carried out, which will be indicated as Ex periments A. B. and C.

EXPERIMENT A.

This was merely a continuation of the prev ious year's experiments, using the same ob servation posts and methods of attack.

EXPERIMENT B.

Reason for Experiment B.

1. To make observations on root developme in newly planted nursery stock.
2. To determine at what time the new rootlet first commenced growth and at what perio most growth was made.
3. To determine the nature of this growth an on what section of the root for the mos part this new growth developed.
4. To obtain an estimate of the total roo growth made during winter.
5. To note the effects of temperature, wate table etc.

Plan of Experiment B.

1. Two trenches 30 ft. long and 8 ft. wid and 2 ft. deep were dug and filled with a mixture of ¾ riverside sand and ¼ th original soil.
2. 60 young Delicious trees one year old stock were purchased from a local nursery and planted in this sand mixture.
3. Reasons for the sand: (a) to facilitate dig ging and observation, (b) original soi was a heavy sticky clay.
4. The first trench was planted on Novembe 10th, 1923.
4. The second trench was planted on Novem ber 12th, 1923.

Treatment of Trees

1. In most cases all root fibres were removed leaving only the larger roots with the tips pruned off.
2. Some trees were planted as received with all the fibres left on.
3. Others were deliberately mutilated with a jack knife.
4. Some were planted in the original soil (a) with the fibres left, (b) with the fibres removed.

EXPERIMENT C

Trees (1 year) were taken from the field to the laboratory and placed in the following culture solutions (Shives best).

Culture Solution

1. 17.64 gms. KH_2PO_4; 7.65 gms. $Ca(NO_3)_2$. 21.69 gms. $MgSO_4$ and 1cc. of $FePO_4$ solution, making up to 9 litres with distilled water.
2. The above solution aerated by apparatus. (Fig. 3).
3. The same solution with CO_2 passed into it. (Fig. 3).
4. Water cultures.

Reasons for Experiment C.

1. To determine whether young apple trees could be grown in neutral solutions and water cultures.
2. To note the effect of aeration, i.e. O_2 supply, and of carbon dioxide on root activity in these solutions.

CONCLUSIONS

Experiment A.

1. The fall of 1923 was very dry and while from October 6th on there was sufficient moisture to keep apple roots growing slowly there was not sufficient to maintain root growth of filberts.

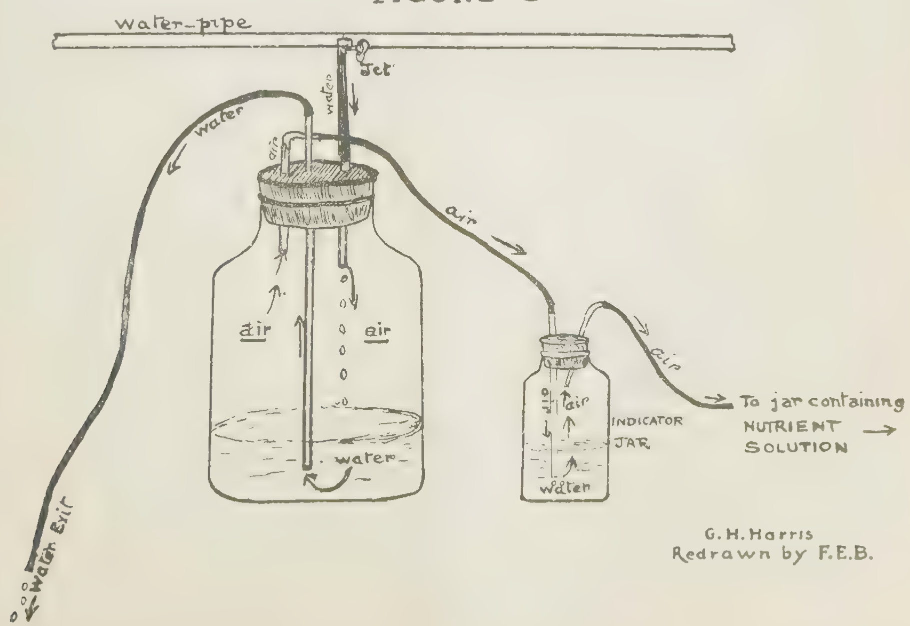
2. Filberts however, will stand submergence for longer periods than apples and continue root growth longer with deficient aeration.

(a) While it was an exceptionally fine fall as compared to the previous year, everything was 3 to 4 weeks later in the Filbert blooming period. (This may have been due to the fact that there was no root growth at this time due to drought.)

3. As in the previous winter's work, freezing temperatures in the soil checked growth but if roots have not been submerged just previously or are so at the time of freezing, the damage done is small, and growth commences again as soon as favourable conditions appear.

The soil temperature at 6 inches reached 28 degrees F. around December 31st to January 3rd, and 32 degrees F. at the 10 inch

FIGURE 3



depth. At the six inch depth growth stopped for 10 to 14 days, and at ten inch depth only for 4 or 5 days as the weather immediately afterwards became quite warm. At this time none of the roots were subjected to submergence. However, around January 21st the water table came up to the surface in the low lying places. The temperature at this time was well above freezing, around 40 degrees F.

This submergence killed off all small rootlets while the larger ones turned black and appeared dead, but growth started from them again four to six weeks later by new side shoots. The old roots did not themselves make further growth.

The ratio of the freezing check to the submergence check was 2:5; moreover the root area due to submergence was considerably reduced due to the death of the small rootlets and the older ones not renewing growth themselves but sending out weaker side shoots.

4. The freezing check did not cause any reduction of root surface other than loss of two weeks' growth.

5. The chief factors in checking root growth during the winters 1923-24 were (1) drought, (2) freezing temperatures, (3) submergence.

When these factors do not play a part, root growth can be expected all winter long.

Experiment B.

1. Three trees were dug up each week for examination and then replanted. Different trees were used each time.

2. The first sign of growth was on Decem ber 5th, 1923, or less than a month afte planting.

3. From that time on roots kept coming ou irregularly during the entire winter.

4. At the final digging on June 9th, 1924 on the same root system were roots of ap proximately one foot in length having taker all winter to reach that size and "new starts" as well as all graduations between.

5. There is no special time for roots tc grow; they do so whenever conditions are favourable.

6. On one end of the trench where the roots were submerged checking was very slight, due to the efficiency of the sand in allowing aeration.

7. It is very noteworthy that in every case the old original root system was the same and an entire new system had sprung from the old one.

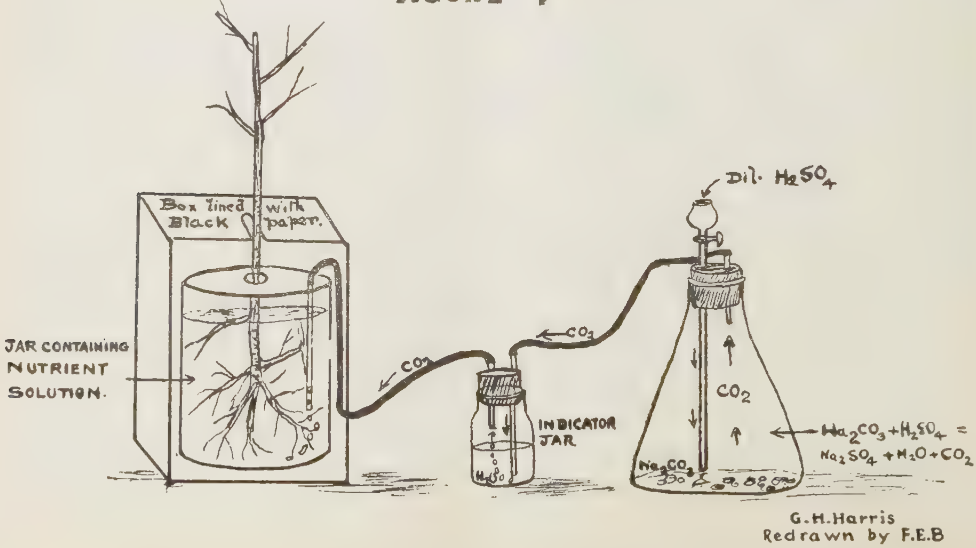
Nature of the New Growth

1. In practically every case in the sand plots the new rootlets had sprung from the cut ends of the original roots or wherever a cut had been made, but more especially from the cut ends. (Fig. 5).

2. In some cases roots appeared from other portions, but these were in the minority.

3. Where the roots had been submerged and the top layer became puddled and baked, roots developed more from the collar region.

FIGURE 4



4. In the original soil nearly all the new gorwth sprang from the collar region, the minority being from the cut ends. (Fig. 6).

(a) This would appear to demonstrate the value of aeation, the best air supply, and consequently the best root development, being near the surface.

5. In the heavy soil the new root system was not nearly so extensive as in the sand.

6. Removing the fibres apparently made no difference as these fibres made no growth and in the majority of cases dried off. The main scaffold branches on the root form a better base for new roots to spring from, also the larger the number left on the greater is the available food supply for new rootlets to draw on. It should be noted that all root activity during winter is due to the drawing on the accumulated stored food. The reason that the fibrous rootlets do not function or send out new growth is that they have not sufficient, if any, food stored up to nourish new growth.

Results of Experiment C.

1. Two trees showing no activity (either in root or top) were brought into the laboratory and placed in the nutrient solution January 12th, 1924.

There were no signs of activity until the solution was aerated in the one case by means of the apparatus shown in Fig. 3. This started on January 30th, following which by February 6th leaf growth had commenced and rootlets began to appear on Feb. 14th. They were ¾ inch long and for the following week grew at the rate of 1 c.m. per day. From that time on the rootlets elongated more slowly but threw out numerous side branches. The aeration treatment was continued up to June 10th, and the solution changed only four times. On this date the tree was healthy, had made 8 top branches, 6 of which were 14 inches long, and the other two 7 and 8 inches respectively. These branches were longer than those outside at this period but not so stout.

The root system was well developed and well distributed over the old root surface especially at the pruned ends.

Up to March 1st the tree in the laboratory was much further advanced than those outside, but after that date those outside did better.

On February 21st, another tree was brought in having good root growth. This was placed in a similar receptacle and given the same aeration treatment as the other until March 2nd, when the aeration was cut off and CO_2 passed into the solution instead (by means of the apparatus shown in Fig. 4). Growth appeared normal for two weeks and then halted and remained stationary until April 1st when the smaller rootlets began to die off. By April 20th, practically all new growth had blackened and taken on symptoms of death similar to those in the field killed by submergence. This seems to verify the experiment and shows that it is the cutting off of aeration (or accumulating of CO_2) and not the actual submergence which does the damage. Stagnant water or submergence for any period cuts off air supply. The tree brought

FIGURE 5.
TYPICAL CHARACTER OF ROOT DEVELOPMENT IN LIGHT SOILS.

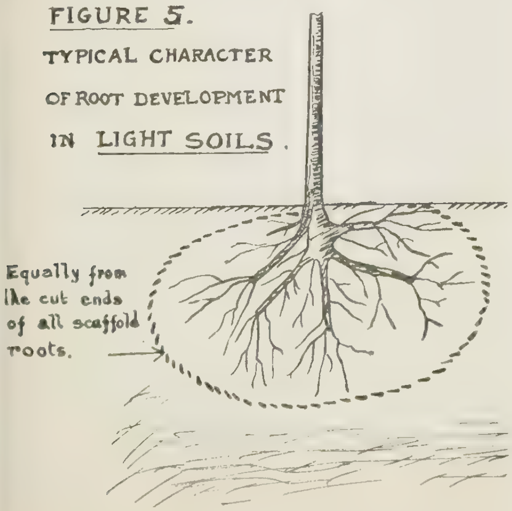
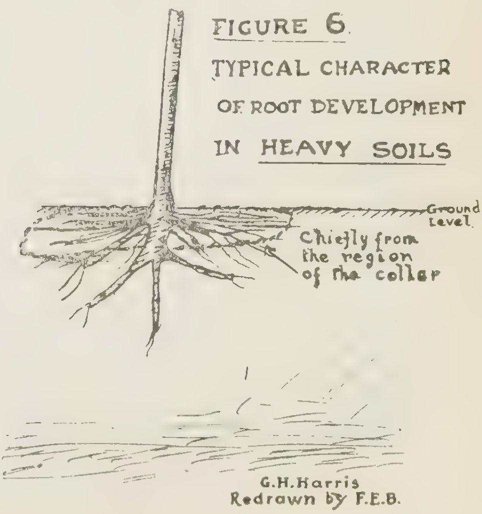


FIGURE 6.
TYPICAL CHARACTER OF ROOT DEVELOPMENT IN HEAVY SOILS



in and placed in the solution and not treated with O_2 or CO_2 could not be kept healthy unless the solution was changed every 4 days.

2. Another tree just placed in pure water made good root growth when the water was changed daily until the new root growth got beyond 1½ inches to 2 inches, when the roots became very spindly and lacked vitality.

Summary of Two Years' Work

1. Tree roots, provided they are not submerged and are not subject to freezing temperatures, or excessive drought, continue their growth irrespective of season.

2. In localities where mild winters are prevalent it is apparently the natural condition for a tree to continue root growth during the winter months.

3. If submergence occurs closely followed by freezing temperatures a serious situation arises.

4. A cessation of root growth and submergence or puddling of soils are effective factors for cutting off aeration. If continued for any length of time small rootlets are killed and the large ones cease growth for prolonged periods, thus causing a very reduced root area under such conditions.

5. If the soil is well drained (or aerated) submergence for short periods does little if any damage.

6. Filberts continue root growth with a greater deficiency of O_2 than apples. They will not, however, stand as much drought.

7. There is no special time for roots to grow but whenever conditions are favourable for root growth, growth occurs and whenever unfavourable it ceases, irrespective of the time of year.

8. In the case of newly planted trees the original root system plays very little part other than acting as a source of food supply and as a base for new roots to spring from; also as an anchorage. One year's observations showed practically no increase in size of original roots, except possibly a slight increase in thickness.

9. The nature of the new growth in young trees depends on the medium in which they are planted. (1) If in sandy soil where there is good aeration new growth is distributed all over the original root system. (2) In soil which is heavy and deficient in aeration new growth is formed mainly from the collar region near the ground surface. (3) Wherever roots are pruned or cut new growth springs abundantly from such cut areas.

10. Carbon dioxide in excessive amounts causes death to roots.

11. Apple trees can be grown successfully in nutrient solutions provided the solution is changed frequently (every 3 or 4 days). If some other means of aerating the solution is provided, they can then be kept going for prolonged periods without a change.

Practical Applications

The growth of roots during the winter months and their continued activity renders them (and incidentally the tree) very susceptible to freezing damage in the winter and we can expect far more winter injury in climates where mild winters are prevalent than in climates where the winter is normally severe and the ground stays frozen. Sudden changes from cold to warm weather are liable to be very detrimental as the observations show how readily the roots become active and root growth starts almost immediately conditions are favourable. All new growing rootlets are in the "white" stage and it is during this stage that damage occurs. When roots are in the brown or protected stage, they are safe, and in climates where the winter is cold and stays cold they pass into and remain in this condition.

The detrimental effect of root submergence has been shown and at no period should stagnant water be allowed to remain in the orchard. Moreover, heavy puddled or baked soils are similarly detrimental to root growth. They also tend to choke off an adequate air supply so essential to most of our fruit trees.

The grower at all times should keep his soil in good physical condition either by cultivation, cover crops, or by the other methods already recommended. In mild climates it is apparently the natural condition that in order for a tree to continue its normal development throughout the year the roots must make a considerable portion of their growth during the winter, in order that the roots may attain the depth required and avail themselves of a large enough feeding area to cope with the heavy drain made on them during the latter part of the season when moisture is scarce and but little food available. If the roots do not make this required

growth but for some reason receive a check for any length of time, the tree will suffer in varied degrees depending on the length of time growth is checked.

Consequently, do not have trees planted where the water table comes too near the surface, for the reasons given—even if it does so at a time when the tree is presumably at rest. If the trees are already there drainage must be provided.

The foliage of the tree should be kept healthy during the summer because root growth made either during the winter, or in the spring before the leaves are out, is dependent on the amount of food stored up from the year before, which of course depends on the proper functioning of the leaves.

In the dry mountain valleys of the West where the winters are severe and the summer months hot and dry, the growing season of the spr:ng is of such a nature that root growth just previous to leaf formation is very rapid and the same amount of growth must be made in the early spring months after frost gets out of the ground as is made in mild sections during the winter and spring combined, consequently it is very important in the early spring months to have every facility convenient for root growth as this period is critical if an adequate root area is to be formed, which root area has to cope with the drain made on it during the summer. The soil must be in good condition at this time, puddling should be avoided and provision made for standing water to drain away. Early excessive irrigation is undesirable because there is plenty of water available at this time, and because it chokes off the air supply when the root needs it most.

"Sufficient water is plenty" at all times and no advantage is gained by super-saturating the ground.

If possible, roots should be in the brown stage by the time the cold weather starts. In general, moist ground keeps warmer than dry ground, so the ground should be moist when trees go into the winter but not saturated.

In mild climates if the winter is not severe and ground temperatures not subjected to prolonged freezing or sudden drops, fall planting of nursery stock gives best results as a much larger root system will be developed for the summer's work than on stock planted in the spring. Sandy loam soils give the best results in root development due to more efficient aeration.

In selecting nursery stock pay more attention to the larger scaffold roots than to the small and numerous fibrous roots. Prune off all ends in planting but the more main roots left the better, and do not plant when soils are heavy and puddled.

Courses in Agriculture Established at Boys' Training School, Bowmanville, Ont.

E. P. BRADT

Farm Director

An advanced step has been taken to help solve the unadjusted and wayward boy problem in the establishment of a Boys' Training School at Bowmanville.

The plan and idea is a fulfillment of the careful consideration and matured judgment of the Service Clubs and leaders in boys' work throughout the province. They reasoned that the country was losing boys who might be made useful citizens if taken in hand in early life, given wholesome surroundings and an opportunity to show their natural tendencies for certain kinds of work. The boys could then be developed and trained according to the bent which they have displayed.

The Superintendent, Dr. G. E. Reaman, has organized the Staff, keeping in mind the giving of vocational training to the boys, and directing their attention and energies toward the field of endeavour for which they would seem to be most suited, and where they would be most likely to succeed. Tith this in view, an agricultural Department has been organized, along with others, and the writer was placed in charge of this branch in June of the present year.

The course of study in Agriculture with the boys will be kept as much as possible in the nature of project work. In other words, they will learn poultry raising, gardening etc., by being assigned definite work to do, in these different branches, and being made responsible for carrying it out. Boys will be given charge of the operation of incubators and brooders, the raising of young chickens, crate fattening of surplus cockerels, caring for laying pens of hens, and other work relating to the poultry industry.

Thirty acres of ground have been set apart for gardening purposes. On this will be grown the fruits and vegetables required for the School dining-room, and in addition, certain kinds of each crops will be grown for sale. Apart from this regular garden, where quantity production will be carried out, each boy will have small plots, for the upkeep of which he will be made personally responsible. He will be required to measure out the areas, sow the seed, care for the plot during the summer, and harvest and keep records of yields in the fall. The older boys will conduct some experimental work, such as testing different varieties of potatoes, mangels, turnips, and corn. They will compute yields at harvest time, and, in addition to finding out the best yielding varieties, will create practical problems in arithmetic to be worked out in the school class-room. In order to stimulate and keep up interest, the plot work will be kept on a competitive basis. The products from each boy's plot will be assembled and placed on exhibition in the fall and judged on their merits. Prizes will be awarded to the boys growing the best crops.

Milk and cream testing, butter making, the keeping of individual records of milk production in the dairy herd, will be some of the projects carried out in the dairy work. This again will provide many problems in arithmetic, featuring percentages and decimals to be worked out in the class-room. Arithmetic of this kind will really mean something to the boys. Actual problems will be presented that they have met with in their daily work, and not just the ordinary cut and dried school question which they cannot connect with anything they have ever come in contact with.

Farm animals always have an especial appeal to a boy. At the time of writing four boys are fitting calves for the local fall fair. They are halter breaking, feeding and grooming them daily, and each boy will lead out his calf before the judges on the final day.

Agriculture really means something to a boy engaged in the various activities which have been outlined. If you send a boy out into a ten acre field to hoe and weed turnips, that, to him, is slavery. Give the same boy a plot of turnips to call his own and put him on a competitive basis with another boy as to who can grow the best turnips, and you immediately arouse his sporting instinct. The same work takes on new interest and really means something to him. The work part of it is lost sight of and the joy of possession and really doing something becomes the important thing.

Just as far as possible all the agricultural activities in the School will be carried on in a way that will make a direct appeal to a boy's imagination and interest in the things of nature surrounding him. It is not too much to expect that quite a number will be influenced toward the farm. Those who show interest in that direction will be given sufficient practical experience to enable them to go out and be useful help to any farmer, command a fair wage, and ultimately become property owners themselves.

The School farm consists of 300 acres of land. The soil varies from sand to clay loam, and is well adapted for growing all kinds of farm crops. The kind of farming followed will necessarily have to be of a nature to provide for the food requirements of the School first, and any surpluses will be disposed of through regular market channels. Good farm practices will be followed without frills. It is hoped that the farm can serve a useful purpose in the community as a demonstration farm where the practices followed are only such as should be found on any well conducted farm. The whole farm will thus become a laboratory where the boys can see modern farm methods being carried out.

The development of the School is being closely watched by the public generally, and particularly by those interested in boys' welfare work. It would seem to meet a long felt and definite need. The field to work in is a big one and the opportunities unlimited. The next ten years will show just how much of a factor the School can be made in helping to solve at least one phase of the boy problem.

Inbreeding and Hybrid Vigor in Plant Improvement.*

D. F. JONES

Connecticut Agricultural Experiment Station, New Haven.

It is now nearly twenty years since inbreeding, followed by crossing, was first proposed as a method of corn improvement. Although much interest is being taken and extensive corn breeding programs are being carried out in the corn growing regions of North America, this new principle has only just begun to be incorporated into commercial practice.

Why has there been this long delay? Is this the usual time required for new ideas to become known, appreciated and applied? Probably so in this case considering the time needed to produce valuable inbred strains, test them, increase stock seed and make all the adjustments necessary in such a radical change in procedure.

At the same time a new understanding of hybrid vigor has, I believe, hastened its practical application. East, Shull and other biologists at first considered hybrid vigor or heterosis, to use the technical term proposed by Shull, to be a physiological stimulation accompanying hybridization and that this increased growth activity was additional to the normal expression of hereditary units. The dominance hypothesis assumes that the offspring from parents of diverse stock have a greater number of dominant favorable growth factors than either parent and consequently tend to grow larger and faster. This is known to be the case in particular crosses where the working of a few definite factors can be followed. It is assumed to hold for many other factors which have the same effect whose transmission can not be so easily followed.

The tall plants are the result of crossing the two genetically distinct dwarf types. Dominant favorable factors from both parents have combined to make the offspring far more vigorous and productive than either parent.

According to the physiological stimulation idea the hereditary constitution did not matter so much as long as enough germinal differences were involved to give the maximum heterotic effect. But on the assumption, which seems well supported, that hybrid vigor is merely the expression of hereditary factors the results obtained from any cross depend entirely on the hereditary constitution of the stocks combined. The factors which make a hybrid vigorous are just as effective (and probably more so) in the homozygous condition as in the heterozygous. Crossing is merely the easiest and quickest way of getting the largest number and the best assortment of them together and in most cases the only way of doing this.

The first attempts to apply inbreeding and crossing to corn improvement were somewhat discouraging because, in the few combinations tested, none showed any outstanding increase in productiveness over the original stock. At the Connecticut Agricultural Experiment Station many combinations of inbred strains show no advantage over the original variety in grain production although all

*A summary of two lecturers at the Sixth Annual Convention of the C.S.T.A., June, 1926.

are more uniform. A few crosses do show exceptional merit and fortunately this is all that is necessary.

It is now clearly apparent that inbreeding and selection must be applied on a large scale in order to get some strains that have outstanding value. When good combinations of inbred strains are once produced they can always be reproduced by remaking the same cross. The uniform production from every plant, the similarity in size and shape of ear, evenness in ripening and the striking ability to resist disease, characteristic of certain crosses of inbred strains of corn, show that an entirely new kind of seed has been produced.

The best methods of utilizing the large amount of material that has resulted from extensive selection in self-fertilized lines has yet to be worked out. Several methods are available, each having certain advantages and disadvantages. These have been discussed in bulletin 273 of the Connecticut Experiment Station.

The attempt to improve naturally cross-fertilized plants by the selection of the best appearing individuals in heterozygous material, as has been so generally practiced, must always result in a compromise between uniformity to type on the one hand and vigor and productiveness on the other. Close selection to a single standard will invariably, sooner or later, bring about an increase in consanguinity and a consequent reduction of growth. Selection in self-fertilized lines establishes uniformity and constancy first. During this process of inbreeding and after homozygosity is reached, it is possible to select those characters of type that are desired, as has been shown in bulletin 266 of the Connecticut Agricultural Experiment Station.

Maximum vigor and productiveness are secured by crossing in suitable combinations and a far greater uniformity and productiveness have been obtained than has heretofore been possible in such a notoriously variable species as maize. Similar methods, with modifications, can be applied to other cross-fertilized plants to advantage.

The uniform production from every plant is what makes the crosses of inbred strains so productive.

Similarity in size and shape of ear and evenness in ripening are characteristic of crossed corn.

Dominion Department of Agriculture Notes.

EXPERIMENTAL FARMS BRANCH

Horticulture Division

The Dominion Horticulturist, Mr. W. T. Macoun, recently completed his annual visit to the Experimental Farms and Stations in Canada. By conferring with the Superintendents each year and seeing the experimental work in progress, the horticultural needs of the Stations and districts they serve become well known and he is able to render aid in the development of the work in a way that would not otherwise be possible.

On Vancouver Island there is much interest, among many other things, in flower seeds, bulbs, strawberries, logan berries and tomatoes and every effort is being made at the Station at Saanichton to help those engaged in developing these crops.

At the other Stations in British Columbia, at Agassiz, Summerland and Invermere, many experiments are being conducted, the results of which are of great value to the people. At Invermere, potatoes and peas receive much attention, as these two crops do particularly well there. The Summerland Station serves the Okanagan district and the field of work is very broad but cultural orchard experiments, methods of storage, origination of new varieties and the develop-

ment of better vegetables are some of the main lines of work.

The prairie provinces are well served with Experimental Stations and the horticultural work at them all is proving of great value to the settlers. The newer varieties of vegetables originated in the Horticultural Division, such as Pickaninny, Banting and Early Malcolm corn, Alacrity tomato, and Ruby rhubarb are of particular value on the prairies and are being much appreciated.

In North Ontario and Quebec, at Kapuskasing and La Ferme, the horticultural work means much to the people in those newly settled districts. Much money is saved to them through the failures experienced at these Stations and the knowledge of the varieties which do well and the methods found successful result in a great saving also.

Among the other Quebec Stations, the fine orchard which has developed at Ste. Anne de la Pocatière is one of the most striking results of the horticultural work. Here, some seventy miles below the city of Quebec, climatic conditions are very favourable to the growing of apples, plums and cherries, as well as the small fruits, and many varieties have succeeded admirably there. Some of the best of the new varieties of apples originated in the Horticultural Division do well there, fine fruit having been produced of Melba, Joyce, Lobo, Nume and many others.

The Maritime Stations, at Fredericton, N.B., Nappan, N.S., Kentville, N.S., and Charlottetown, P.E.I., are all rendering much service. At Fredericton the orchards have developed well and the new apples, Melba, Lobo and Sandow fruited there promise to be three important additions to New Brunswick orchards. At Kentville, among the many experiments in progress, perhaps one of the most useful is the statistics which are being gathered of the relative yields and value of fruit of different varieties, three of which were planted in the same year. These data are of the greatest value to those setting out new orchards.

Many are now visiting Prince Edward Island during the summer months and the wonderful display of bloom at the Station at Charlottetown in connection with the experimental work with flowers, particularly with dahlias, sweet peas and other annuals, must have a marked effect in giving a good impression of the possibilities of the Island, and the Islanders themselves are moved to beautify their homes and add to the charm of thi fine Province.

Bee Division

Notes Re Honey Crop of Canada

The past season has been a disappointin one for beekeepers in Eastern Canada, espec ially in the Provinces of Quebec and Ontario An extremely long winter, with heavy losse in bees, followed by unfavourable weathe conditions throughout the spring and summe resulted in an unusually light crop of honey In the West, however, the exact opposite wa prevalent. While it is true that in Manitoba winter losses were rather heavy in some locali ties and that spring weather was not of th best, the summer conditions were favourabl and fair crops were gathered. In Alberta Saskatchewan and British Columbia a com paratively short, mild winter was experienced and the bees wintered well. The winter was followed by a warm, early spring, which enabled the colonies to build up rapidly on the early sources of nectar in preparation fo the main flow. Summer conditions over the greater part of Saskatchewan and Alberta were conducive to heavy nectar secretion an to bee activity, hence, very good crops o honey were obtained. In the "Park Lands" of Saskatchewan, where Sweet Clover was plentiful, high average crops were gathered In one apiary near Regina as high as 400 fin ished sections were produced by two colonies run for comb honey. The Experimental Farm Apiary at Beaverlodge, Northern Alberta, also reports some wonderful results. The colony on scales at this Station registered a series o daily gains during the month of August, ranging from 15 to 21 pounds per day, and on August 25th this colony stood at a gross weight of 500 pounds. In Central and Southern Alberta the crops are reported to be the best on record. In British Columbia the honey crop is somewhat patchy. In some localities heavy yields have been obtained, while in others the crops were very light, due to extreme dry weather during the summer. Taking the province as a whole, however, the crop is a good one.

Cereal Division

Garnet Wheat

The Cereal Division, of the Experimental Farms Branch, is busily engaged compiling data re the performance of Garnet wheat in western Canada during the past season.

Over 2000 farmers grew this wheat last summer and were asked to submit a detailed report on its performance in comparison with their main crop. Special forms were sent them for this purpose, from which forms data are being tabulated.

The Division contemplates publishing a bulletin in which will be recorded a summary of the merits, as well as the defects, of the above variety. This publication should be an extremely timely one in view of the degree of interest which has been shown in the variety.

ENTOMOLOGICAL BRANCH

Mr. Arthur Gibson, Dominion Entomologist, spent two months this summer (June 12 to August 10), in the Western United States and Canada attending the meetings of the Pacific Slope Branch of the American Association of Economic Entomologists held at Oakland, California, on June 16-19, the Annual meeting of the North-west Association of Plant Pathologists, Entomologists and Horticulturists held at Tacoma, Washington, on June 28-29, and visiting all the entomological laboratories in Western Canada on his return journey east.

An important international conference on matters relating to the spread and control of the European corn borer was held at Chatham, Ont., and Detroit, Mich., on September 24 and 25. Officers from the Entomological Branch who attended this conference, in addition to the Dominion Entomologist, were: Messrs. A. B. Baird, G. M. Stirrett, H. F. Hudson and C. S. Thompson.

Exhibition Work

Instructive and attractively arranged entomological exhibits were displayed at the Central Canada Exhibition at Ottawa, August 23-28, and at the Canadian National Exhibition, Toronto, August 28 - September 11, under the direction of Mr. C. B. Hutchings. Smaller exhibits have also been displayed at most of the more important fairs and exhibitions throughout Canada.

Promotions

Mr. A. B. Baird, B.S.A., M.Sc., officer in charge of the Corn Borer Parasite Breeding Laboratory at Chatham, Ont., was promoted from Assistant Entomologist to Entomologist, dating from June 1, 1926.

The appointment of Mr. C. W. Smith, B.S.A., as Assistant Entomologist, Chatham Laboratory, was made permanent on August 1, 1926.

Mr. W. St. G. Ryan, in charge of inspection work at the port of Montreal, has been promoted from Junior Entomologist to Assistant Entomologist, effective from April 1, 1926.

Mr. S. H. Short, B.S.A., General Foreman of Gypsy Moth Scouting, was appointed to the position of temporary Assistant Entomologist on May 17, 1926.

Mr. J. J. de Gryse, Division of Forest Insects, was promoted from Assistant Entomologist to Entomologist at Ottawa, on June 1, the position having been made vacant by the resignation of Dr. F. C. Craighead.

Division of Forest Insects

Dr. J. M. Swaine, Associate Dominion Entomologist, reports that during the past five years at least six millions of dollars worth of timber, principally yellow and lodgepole pine, have been saved from certain destruction, in British Columbia, as a result of bark-bettle control work carried out by forest entomologists in co-operation with officers of the Provincial and Dominion Forest Branches.

Although the great spruce budworm outbreak of recent years has disappeared from most of our eastern forests, active feeding by the caterpillars occurred last year in Cape Breton Island, Central Manitoba, and in several places in British Columbia. These comparatively minor outbreaks are being studied.

Injury to beech trees in Nova Scotia caused by the European Beech Bark Louse, *Cryptococcus fagi*, has also been under study. This insect has spread over practically all the mainland of Nova Scotia and was found this summer in the central part of Cape Breton Island. In many parts of the province the beech trees are diseased and dying, evidently as a result of primary injury by this insect. A survey made at the close of this season, in southern New Brunswick and Cumberland county, N.S., indicates that southern New Brunswick apparently is not yet infested by the bark-louse and, since beech trees occur very sparsely on the Isthmus of Chignecto, it is hoped that infestation will not spread westward into New Brunswick.

Division of Field Crop and Garden Insects

Mr. George M. Stirrett, M.S.A., was appointed to the position of Entomologist in charge of European corn borer investigations, in the Division of Field Crop and Garden in-

sects, September 15. Mr. Stirrett, whose headquarters are at the Entomological Laboratory, Chatham, Ont., graduated from the Ontario Agricultural College in 1923, and secured the degree of M.S.A. from Purdue University in 1924. He has also taken postgraduate studies in various phases of entomology, plant ecology, biochemistry and biometry at the University of Minnesota leading to the degree of doctor of philosophy. Mr. Stirrett has had much teaching experience and has carried out investigational work on insects in Ontario, southern Texas and southern Indiana.

Messrs. Norman Criddle, H. L. Seamans, K. M. King, H. E. Gray, and J. E. Revell, entomologists in the Branch laboratories in the Prairie Provinces, attended the meetings of the North-west International Committee on Farm Pests held at Lethbridge, Alberta, August 26-27.

Division of Foreign Pests Suppression

European Corn Borer—A very marked spread in the areas infested by the European corn borer has been revealed by the scouting operations conducted in 1926. Infestations were found for the first time in the counties of Victoria, Peterborough, Lanark, Grenville, Dundas, Stormont, Glengarry, Russell, Carleton, Renfrew and Nipissing, and a spread of infestation in the counties of Durham, Northumberland, Hastings, Lennox and Addington, Frontenac and Leeds. The area along the Ottawa River is now generally infested and collections have been taken in Eardley, Hull and Templeton townships in the Province of Quebec.

On August 31st, the corn borer was first found in the Province of Quebec at DeWittville, near Ormstown. Subsequent scouting has revealed infestations in the counties of Beauharnois and Chateauguay and one collection was made in Lacolle township, St. John county.

Gypsy Moth—The Federal Department of Agriculture, Entomological Branch, in cooperation with the Quebec Department of Lands and Forest, continued in 1926, the scouting of all areas in southern Quebec bordering on the international boundary. The first record of the pest in Canada was made near Stanstead early in 1924 and later in the season a very serious outbreak was found near Henrysburg, in Lacolle township, St. John county. No further outbreaks have since occurred. Efforts have been devoted to the control of the insect in the districts where it has been found by spraying the trees, creosoting egg masses, banding trees, cutting and burning brush, burning stone walls, etc. After the clean-up work of 1925, only four egg masses were found and, although the work of 1926 is not yet finished, it is felt that further substantial progress has been made in the effort to eradicate the pest in Canada.

Division of Systematic Entomology

Dr. J. H. McDunnough, Chief of the Division of Systematic Entomology, spent from May 20 to August 4 in the Rocky Mountain region of British Columbia, continuing faunal studies and collecting insects for the National Collection.

Mr. H. L. Viereck, Assistant Entomologist, who had been studying and classifying the hymenoptera in the National Collection at Ottawa, resigned on April 1.

Laboratories

Mr. Arthur Kelsall, in charge of insecticide investigations at Annapolis Royal, N.S., has secured excellent results in apple budmoth control. Under his direction a survey for the apple maggot in Nova Scotia orchards was carried out this summer.

Mr. W. A. Ross, in charge of the entomological laboratory at Vineland, reports good progress in the control of several important orchard pests, notably the pear psylla. Work is also going forward on the oriental peach moth, an important pest of recent introduction. Mr. T. Armstrong, M.S.A., was appointed to the position of Junior Entomologist at the Vineland, Ont., laboratory, on August 17.

Mr. C. E. Petch in charge of the Hemmingford, Que., laboratory, had charge of the Branch exhibits at the Sherbrooke and Quebec Exhibitions.

Mr. Eric Hearle, who is carrying out livestock investigations at Indian Head, Sask., visited Saskatoon early in September to confer with Drs. A. E. Cameron and S. Hadwen in connection with various phases of his research work.

Mr. E. R. Buckell of the Vernon laboratory, B.C., visited the Peace river district, at the end of September, in connection with a severe grasshopper outbreak. He reports that this district has the appearance of being one of the richest agricultural sections in the Dominion.

Mr. R. Glendenning in charge of the laboratory at Agassiz, B.C., directed a successful campaign against the European earwig in Vancouver this summer.

Mr. W. Downes, of the entomological laboratory, Victoria, B.C., in charge of fruit insect investigations on Vancouver Island, has evolved a satisfactory, easily prepared poisoned bait mixture, for the control of the strawberry root weevil.

The following Entomological Branch publications have appeared during the past summer:

"The More Import Shade Tree Insects of Eastern Canada and Their Control". Dom. Dept. Agric. Bull. 63, N.S. April, 1926.

"Nova Scotia Apple Spray and Dust Calendar, 1926". Ent. Branch Pamphlet 65, N.S., March, 1926.

"The Pear Psylla and Its Control" Ent. Br. Pamph. No. 66, N.S., March, 1926.

"The Rose Chafer" Ent. Br. Circ. No. 44 April, 1926.

"The Red-backed Cutworm and Its Control in the Prairie Provinces". Ent. Br. Pamph. No. 69, N.S. June, 1926.

"The Pale Western Cutworm" Ent. Br. Pamphlet No. 71, N.S. June, 1926.

"The Mosquitoes of the Lower Fraser Valley, British Columbia and their Control". Nat. Res. Council, Rep. No. 17, 1926.

SEED BRANCH

Color Stains for Imported Seed

Hon. W. R. Motherwell, Minister of Agriculture, Ottawa, announces that imported red clover and alfalfa seed will hereafter be stained to indicate the country of irigin. This action has been taken to protect Canadian farmers against clover crops which are not winter hardy in our climate, and will probably result in higher prices being paid for the home-grown unstained red clover seed.

The staining regulations are not important as affecting imported alfalfa because we are not heavy importers of this seed, but similar regulations recently adopted in the United States will place our hardy, northern grown alfalfa seed at a premium in their markets.

Large quantities of red clover seed are imported every year. Most of the red clover imported from the United States is perhaps as winter hardy as our main supply from Southern Ontario, but seed from the United States will be stained in the sack to show one per cent colored orange. Seed from England, France, Northern Europe and Chile will be stained green as not fully winter hardy in Canada, except possibly on the Pacific Coast. The red-stained seed from Italy, Africa and Asia is considered least desirable for our conditions. Farmers are advised to increase the production of red clover seed to meet home requirements.

Field Inspection of Turf Grass Seed Crops

Browntop (*Agrostis tenuis* Sibth., *Agrostis vulgaris* With.) is prevalent in Prince Edward Island, Nova Scotia and New Brunswick. In some localities it grows naturally almost to the exclusion of other grasses. Field inspection is necessary because on some farms turf weeds are so plentiful as to destroy the utility value of the seed crop, and in some districts American-grown timothy seed has carried Redtop as an impurity.

The report of seed crop inspection includes a statement of the kinds and prevalence of turf weeds, especially those with seeds difficult of separation, also the percentage purity of the Browntop and the varieties of other grasses present. All fields are condemned if they contain over five per cent of Redtop, which is readily distinguishable after heading and during the blooming period.

The quantity of Browntop seed produced in 1923 was 200 lbs., in 1924 about 3,000 lbs., in 1925 over 17,000 lbs. The field inspection returns for this year indicate that the output will be more than doubled, and the quality generally will be superior to that of last year. The average yield per acre will not exceed 30 lbs. of cleaned seed.

All the growers are members of The Grass Seed Growers' Association, which has established at Charlottetown, Prince Edward Island, a central cleaning plant especially equipped and organized for receiving, cleaning, sacking, storing and marketing turf grass seeds. The Dominion Seed Branch assumes full responsibility for the inspection of the seed crops and for the grading and sealing of the cleaned seed, but has no control over and is in no way responsible for the business affairs of the association. The growers are,

however, well experienced in the sale of farm products on a co-operative basis, and we believe their business proved quite satisfactory to the seed trade last year.

The cleaning plant is now in operation. Each seed lot is received separately with a declaration from the grower identifying it as from the seed crop inspected by our officers. Samples of the cleaned seed are finally drawn by the inspector, analyzed and graded at the Ottawa Seed Laboratory, and sealed in the sack with a metal seal behind which is placed an inspection tag certifying as to the grade and the field inspection. The grade is, however, omitted when the seed is sold for export on actual sample basis. Last year over 60 per cent of the Browntop graded No. 1 under the Canada Seeds Act. The samples ran about 90 per cent of pure seed with an average germination of 90 per cent.

A few hundred pounds of Velvet Bent (*Agrostis canina*) are available this year, also small lots of true Creeping Bent (*Agrostis stolonifera* var. *compacta*) and of Seaside Bent (*Agrostis stolonifera* var. *maritima*).

Dr. M. O. Malte, Chief Botanist of the National Herbarium, has supervised the identification of species, and there is probably no source of supply of fine turf grass seed available in any part of the world that is as dependable in respect of kind and quality as the Bent Grass seed from our Maritime Provinces. Browntop is identical with Rhode Island Bent and the Colonial Bent of New Zealand, and is the chief ingredient of the German Mixed Bent.

LIVE STOCK BRANCH

One thousand horses and twenty-two head of breeding sheep, recently left the Port of Montreal for their long journey to Leningrad, Russia. In these times, when the exporting countries of the World are diligently seeking expansion of export outlet, every new channel that is opened for the disposal of the surplus from Canadian Agriculture, is bound to be looked upon with more than usual interest.

It is about two years since enquiries were first made as to the possibilities in Canada, for supplying Russia with a type of horse, inexpensive, but which would meet the necessary requirements as regards weight, stamina, and thrift.

The horses in the shipment, loaded at Montreal on S. S. Hyacinthus, were purchased and exported under the direction of the Federal Department of Agriculture through the Live Stock Branch, directly as a result of arrangements completed with the Canadian representatives of the Russian Government, who arranged the financing of the transaction, through funds placed in the Canadian Bank for that purpose, and drawable on by the Dominion Live Stock Branch. The horses were selected from the range in the Prairie Provinces and British Columbia, and, until cut out for examination by the Dominion Live Stock Branch's buyers, had not previously been haltered. While the horses, weighing around 1000 to 1250 pounds, geldings and mares, represented a type for which there is a very limited demand in Canada, and which is not considered a permanent asset to the horse industry of this country, they were nevertheless fully up to the particular requirements of the Russian order, and seldom has a finer lot of blocky, hardy, thrifty and well footed beasts, admirably suited to general purpose, or light road work, in a rigorous climate, been assembled for ocean export. It is confidently expected that the shipment will fully meet with the approval of the importing country and result in orders being placed for future shipments.

The consignment of sheep, though small in numbers, was of exceptionally good quality and will undoubtedly uphold the good reputation which Canadian grown stock has invariably enjoyed in whatever country importing. The consignment to Russia was made up of 10 Shropshire ewes, 5 Shropshire rams, 5 Hampshire ewes and 2 Hampshire rams, and was selected for the Russian Government representatives by Mr. A. A. MacMillan, Chief of the Sheep and Swine Division, Dominion Live Stock Branch. These sheep, together with like purchases from the United States and Great Britain, will be placed on an experimental farm near Leningrad, and it should be quite interesting to learn how the Canadian consignment compared with those from other exporting countries.

The whole transaction as regards both horses and sheep, was under the personal direction of Mr. H. S. Arkell, Dominion Live Stock Commissioner.

Conceptions récentes en matière de classification des sols.

H. M. NAGANT

Professeur à l'Institut Agricole d'Oka

(suite) *

3o Le type de sol des steppes "Tschernosem", ou "Terre noire".

Il correspond aux régions tempérées possédant un climat déjà plus sec que celles des terres de podsol. La décomposition de la matière organique procède lentement, l'humus étant saturé de chaux est peu mobile et s'accumule. Cette immobilité empêche aussi l'infiltration des matières limoneuses dans les couches sous-jacentes. Les sels provenant de l'humification et de la dégradation des minéraux sont incomplètement lessivés; ceux qui sont le moins solubles, tels que $CaCO_3$ et $CaSO_4$ se déposent dans le sous-sol et parfois dans les couches superficielles L'altération des silicates est peu intense, il ne se forme que des sels faiblement acides et pas d'argile (Glinka).

Suivant Aarnio et Stremme, le sol des steppes, dans sa forme la plus parfaite, possède un équilibre entre les matières minérales. Dans les horizons supérieurs, il n'y a ni délavage ni enrichissement en produits minéraux de dégradation. Seul l'humus, qui est complètement coagulé et presque insoluble dans l'eau, s'accumule plus ou moins dans les couches supérieures. Dans certaines régions de la Russie, la puissance de cette couche humifère peut varier entre 70 et 150 centimètres. La teneur en humus oscille entre 4% et 20%. Ce type de sol s'observe la où règne une végétation herbacée luxuriante. Voici ce que dit le Dr. Peter Treitz, de Budapest (Hongrie) (7) sur la manière dont le terreau noir se forme dans les horizons supérieurs du tschernosem. "Dans les couches supérieures, épaisses de 60 à 120 centimètres, se localise la matière organique lessivée de la couche de litière superficielle sous l'influence de l'eau chargée de $(NH_4)2\ CO_3$. Cette solution colloidale se dépose dans les couches inférieures, par suite de floculation.

Une partie de l'humus déposé de cette manière se décompose chaque année, tandis qu'une autre s'emmagasine pour l'année suivante."

Il est très intéressant aussi d'attirer l'attention sur le rôle attribué aux animaux fouisseurs, par le même savant, dans l'édification de ce type de sol. Ils rigolent et perforent le terrain jusqu'à une profondeur de 5 mètres, et cela en un temps relativement court. Aussi les profils des sols des steppes montrent dans le sous-sol, (muttergestein) des taches sombres de forme arrondie ou allongée. Ce sont les anciennes galeries de ces animaux fouisseurs, qui ont été remplies de terre humifère. Suivant les dernières recherches, dit toujours le même auteur, ces animaux ont contribué à la formation des loess. L'absence de toute stratification apparente dans les dépôts de loess devrait être attribuée à leur activité de creusement.

Le tschernosem typique passe insensiblement des variétés plus ou moins lessivées aux podsols, à mesure que le climat gagne en humidité, et il se forme des sols forestiers gris ou bruns.

Dans le cycle évolutif que peut parcourir un sol, c'est à cette phase du tschernosem qu'il atteint, comme le dit le Dr. Vilensky (8), le point culminant de toutes ses propriétés, de sa puissance et de sa productivité. "C'est avec cette phase que finit aussi la première période progressive de l'histoire de son développement. Après cela, le sol passe, avec les changements ultérieurs qu'il subit, à la seconde période, celle de régression et d'acheminement vers la mort. Elle commence avec les sols forestiers gris-noisette qui se forment généralement à la suite de l'envahissement des terres noires par les forêts. Par suite de l'élimination du CaO absorbé, les humates deviennent mobiles et sont entrainés dans les profondeurs. Avec la décomposition de la matière organique, son influence protectrice et conservatrice disparait, et un processus énergique de désagrégation de la matière minérale du sol commence à se dérouler. Il aboutit alors à entrainer les oxydes à une

*Voir, première partie, numéro d'Octobre de la Revue Agronomique Canadienne.

profondeur plus grande dans le sol. Le CO_2 qui se dégage en abondance, grâce à la minéralisation intense des résidus organiques, joue probablement un grand rôle dans ce dernier processus de la formation d'un sol cendreux pauvre, ou podsol, terme du cycle de son évolution."

Remarquons cependant, que si, normalement, un sol de steppe ou tschernosem passe graduellement au sol typique supportant la forêt, à la suite d'une modification du climat qui devient plus humide surtout, phénomène que le Dr. P. Encoulesco, de Bucharest, Roumanie, (9) appelle *dégradation*, il arrive aussi que l'on observe le phénomène inverse, d'un retour dans le cycle d'évolution.

Ainsi l'auteur que nous venons de citer désigne par le terme de *regradation*, le fait d'un sol de forêt ou podsol dégradé qui revient, petit à petit, au type du tschernosem, après un long espace de temps, à la suite de la substitution de conditions climatériques subhumides ou semi-arides à des conditions humides. Dans ces conditions, la lévigation des sels solubles, du $CaCO_3$ principalement, s'arrête; il se produit au contraire un certain relèvement de ce dernier vers les horizons supérieurs du sol. Des exemples de ce phénomène seraient observables en Roumanie.

Au point de vue pratique, nous avons des exemples de cette haute puissance de productivité que possèdent les sols arrivés à l'étape du tschernosem, dans les terres noires de la Russie et de la Hongrie, le classique réservoir à blé de l'Europe, malgré les méthodes rudimentaires de culture qui y sont en vogue; nos terres noires des prairies de l'Ouest et, notamment, le sol merveilleux qu'on rencontre aux environs de Winnipeg, autre grenier à blé qui sert à l'approvisionnement du monde.

Les trois grandes classes de sols que nous venons de décrire constituent les sols zonaux complets, de la classification de Sibirtzev (10). Ces sols sont distribués en zônes plus ou moins continues, ceinturant les continents, suivant les variations climatériques.

Mais il est des cas où des facteurs locaux particuliers de formation des sols dominent les facteurs zonaux généraux. On aura alors à faire à des sols dits intrazonaux, tels que:

4o Le Rendzina ou sol humique calcai

(Aarnio et Stremme) (6)

Ces auteurs le décrivent comme un ty de sol prenant naissance sur les calcair friables ou marnes. La couche supérieure e riche en matières humiques difficilement so ubles dans l'eau. L'accumulation d'hum fait que la teinte foncée ou noire de ce s ressort surtout dans les conditions humides

Au cours du processus de formation de c sols, la chaux est délavée tandis que les mi éraux silicatés et leurs produits d'altératic restent comme résidu. Il y a enrichisseme en acides siliciques, en sesquioxydes et e potasse.

Quand toute la chaux est delavée de l'hor zon supérieur, les matières humiques devie nent mobiles et le "rendzina" passe au typ du podsol.

5o Sols salins. (Aarnio et Stremme)

Ordinairement les sols salins se former dans les zônes climatériques où les précipita tions atmosphériques sont faibles, moins él vées que dans les régions de steppes.

Ils se distinguent par une accumulation d sels solubles, de composition variable, dan les horizons du sol. Les sels dominant dan les sols salins sont les chlorures, les sulfate et les carbonates alcalins; la quantité de se peut aller jusqu'à 2.5%.

Pendant la saison humide, la majeure par tie des sels descend dans les couches infér ieures, tandis qu'en temps de sécheresse il remontent par capillarité pour venir cristal liser à la surface.

Chose curieuse à remarquer, c'est que, dur ant leur déplacement, les sels se transformen de sorte que leur composition pourra varie au même endroit, suivant les saisons. Ains par exemple, durant la saison humide, le sulfates alcalins se déplaceront en profondeu où ils réagiront avec du $CaCO_3$ rencontré pour former des carbonates alcalins et du $CaSO_4$ suivant la réaction:

$$Na_2SO_4 + CaCO_3 = Na_2CO_3 + CaSO_4$$

Le $CaSO_4$, peu soluble, se déposera dans les couches inférieures, tandis que le Na_2CO_3 remontera à la surface, par ascension capillaire de sa solution, durant la période de sécheresse.

Suivant leur composition, les sels agiront comme coagulants ($NaCl$, Na_2So_4) ou défloculants (Na_2CO_3) et les sols acquerront une structure granuleuse ou compacte.

Mais on peut aussi rencontrer des sols salins ous un climat humide, lorsque le niveau de 'eau souterraine est élevé et que les solu- ons salines remontent par capillarité jusqu'à ı surface pour y cristalliser. Les sels sont lors principalement représentés par des sul- ıtes de Na - Ca et Al, et peu par des chlor- res.

Aux sols salins, on pourrait encore rat- ıcher le type "Solonetz" de Glinka, qui est n sol alcalin dont l'humus saturé par la oude est rendu mobile. Les sols alcalins ne eprésentent donc qu'un cas particulier des ols a salins.

o Les types de sols des marais (Glinka)

Ici l'excès d'humidité ralentit la décomposi- on des matières organiques qui s'accumulent ous forme de tourbe. L'absence d'oxygène bre entraine la formation de sels ferreux ls que le carbonate ferreux ($FeCO_3$), le hosphate ferreux: $Fe_3(PO_4)_2\ 8H_2O$, des sul- ures (FeS–FeS_2) et de sulfate ferreux ($FeSO_4$).

o Sols d'eau souterraine Grundwasser Böden (Aarnio et Stremme) (6)

Suivant ces deux auteurs, le "gleiboden" ou utot l'horizon du "*glei*", (terme russe), peut rencontrer dans différents types de sols, tels ie, par exemple, dans les "podsols" et les ls salins. L'analyse chimique démontre que est principalement de l'oxyde de fer qui se pose dans l'horizon du glei.

Il appert des recherches expérimentales de Aarnio (11) que si on mélange une solu- on d'humus avec un hydro-sol d'hydrate oxyde de fer, l'une ou l'autre de ces sub- inces sera précipitée, suivant le rapport antitatif qu'elles présentent dans le mél- ge.

On peut donc supposer qu'à l'état naturel, y a précipitation du moment que l'eau uterraine remonte par capillarité jusque ns les couches où la concentration requise cet effet est atteinte. Il serait encore prob- le que des actions oxydantes directes con- buent également à la précipitation de l'hy- ate d'oxyde de fer.

Comme le dit B. Frosterus, le terme final ce processus d'enrichissement qui à l'en- ntre de la "podsolisation normale" n'est s en rapport avec un lessivage, est la forma- n de taches et de bandes plus ou moins mpactes, formées des particules minérales nentées par un mélange d'oxyde de fer et humus. On a adopté pour cet horizon d'enrichissement, de couleur ocreuse, la dénomination russe de "glei".

En Allemagne, ces couches durcies par la précipitation d'oxyde de fer et d'humus sont depuis longtemps connues sous le nom de "Ortstein" qui se traduit en français par "alios", "hardpan" en anglais. Ce terme désigne d'ailleurs aussi, comme on l'a vu plus haut, la couche cimentée par de l'oxyde de fer dans le profil des podsols normaux. Notons encore que cette formation d'alios est un phénomène très commun dans les plaines sablonneuses pauvres de la Campine (Belgique) et celles de l'Allemagne du Nord. Les sylviculteurs, notamment, le connaissent bien et le redoutent par l'obstacle qu'il oppose aux tentatives de boisement de ces terrains. On observe fréquemment que la croissance des plantations de jeunes pins s'arrête net au bout de quelques années; les arbres deviennent rabougris et ne sont pas plus développés après 30 ou 40 ans qu'ils ne l'étaient à l'âge de cinq ou six.

Ce fait est presque toujours dû à la formation d'un horizon de 'glei" ou "alios" qui empêche les racines pivotantes des jeunes pins de pénétrer plus avant dans le sol, compromettant ainsi leur développement normal.

Expériences sur la valeur, comme source alimentaire pour les plantes, des différents horizons du profil du sol.

B. Frostérus (3) décrit comme suit la manière de pratiquer ces essais:

Afin de mettre à profit pour les cultures les indications obtenues à la suite des recherches théoriques sur les variations dans les types de sols, il fut fait des essais de culture dans des terres extraites de différents horizons des profils de sols. A cet effet, on choisit des parcelles d'expériences, représentatives des différents horizons des profils de sols. d'une superficie de, par exemple, un are, c'est-à-dire, un carré de dix mètres par dix. Cette surface étant divisée en cent petits carrés d'un mètre, chaque deuxième carré fut choisi pour l'expérimentation, de sorte que l'ensemble de ces divisions représentaient les carrés de même couleur d'un damier. Ensuite chaque carré fut évidé sur une profondeur de 30 centimètres et la terre enlevée fut remplacée par celle de l'horizon à étudier. Cette terre fut prélevée sur le champ voisin de la parcelle expérimentale. Dans chaque

champ d'expérience, un même horizon ou couche était représenté par une série d'au moins quatre petits carrés d'un mètre. L'établissement du champ d'expérience se fit à l'automne et chaque carré d'expérimentation reçut à cette époque, une application de cinq kilogrammes de fumier.

Les résultats obtenus à la suite de ces expériences indiquèrent notamment que les meilleurs rendements correspondaient aux couches mélangées par des cultures précédentes. Parmi les couches plus profondes du profil d'un sol podsolé normalement, la couche d'enrichissement donne ordinairement un meilleur rendement que le sous-sol ou les parties affectées par la cimentation (formation d'alios).

L'agrogéologie en France

Jusqu'ici, les savants de l'école agrogéologique russe n'ont guère eu de disciples en France et c'est à peine si leurs travaux commencent à trouver un écho dans la littérature scientifique agricole française.

La chose s'explique d'ailleurs, d'une part du fait que le territoire de la France, comparé à ceux de la Russie, des Etats-Unis ou du Canada, est peu étendu, et que les différences climatériques y sont peu importantes d'une région à l'autre. Par contre, les formations géologiques et la nature des roches-mères qui ont donné naissance aux sols de France sont extrêmement variées.

Dans ces conditions, il est clair que le mode général d'évolution des sols de la France sous l'influence d'un climat plutôt tempéré et humide, qui est la caractéristique pour l'ensemble de son territoire, sera presque identique dans toutes ses parties, tandis que le facteur géologique, par la grande diversité des roches mères, devient prépondérant et a attiré bien davantage l'attention au point de vue pratique.

C'est pourquoi le grand développement donné à l'étude de la géologie de la France, au cours du siècle dernier, et l'exécution de cartes géologiques détaillées, couvrant tout le territoire, ont dominé la direction des études agrogéologiques dans l'agronomie française.

Pour le démontrer, le professeur Agafonoff (10) cite Risler, qui affirme, dans son traité "Géologie agricole" (en 4 volumes, 1885), après de Lapparent, que la meilleure carte agronomique est la carte géologique, détaillée, exécutée à grande échelle, telle, par exemple, la carte éditée par le service géologique [de] France. Ces cartes géologiques, suivant Ri[s]ler, doivent devenir la base des travaux d[es] chimistes et des ingénieurs agricoles, comm[e] des forestiers, qui auront à diriger l'aménag[e]ment rationnel des matières minérales et d[es] eaux de la France.

Dans les quatre volumes de sa géolog[ie] agricole, Risler donne une description gé[o]logique détaillée des différentes régions de [la] France et même de certains pays du no[rd] de l'Europe et essaie de coordonner les sy[s]tèmes agricoles correspondants avec la stru[c]ture géologique des terrains; la descri[p]tion des sols eux-mêmes prend relativeme[nt] très peu de place, nulle part n'est décrite [la] structure du sol dans les coupes vertical[es] naturelles ou artificielles, nulle part [la] formation de tel ou tel sol n'est mise [en] relation avec les facteurs climatériques (1[1]).

C'est encore au point de vue géologiq[ue] exclusivement que se place le professeur [L.] Waguet, de l'Institut Agricole de Beauva[is] (France), dans la magistrale conférence aya[nt] pour titre: "Origine et formation des terr[es] arables," prononcée devant la 2ème Comm[is]sion de la Conférence internationale de Péd[o]logie, réunie à Rome au mois de mai 192[4] (12).

Citons, d'après le rapporteur, le résumé [de] sa conclusion: "L'auteur explique les pri[n]cipes de l'agrogéologie en tant que scienc[e] et montre pourquoi l'on doit considérer [la] terre arable comme un véritable objet d'étu[de] géologique", ce que ne font en généal ni l[es] géologues ni les chimistes."

S'il est vrai que le professeur Waguet d[é]crit les agents physiques, chimiques et biolog[i]ques qui contribuent à la formation du s[ol] arable, d'ailleurs suivant l'exposé ordinai[re] qu'on trouve dans tous les traités de chim[ie] agricole, il ne fait cependant aucune allusio[n] à l'action spécifique et essentiellement variab[le] due au climat, ni à certains facteurs locau[x] étudiés avec soin par les agrogéologues [de] l'est de l'Europe. Les cartes géologiques [de] France qui sont supposées pouvoir servir tell[es] quelles de cartes agronomiques, indiqueron[t] par exemple, les dépôts de limon quaternair[e] partout où leur épaisseur est assez grand[e] pour que les labours ne les dépassent pas. O[r] comme le fait remarquer Agafonoff, Risl[er] n'établit donc pas de distinction entre [le] limon parfois épais de plusieurs mètr[es] et le sol qui s'est formé sur ce limo[n]

et dont l'épaisseur ne dépasse pas 8 à 16 pouces. Dans ces conditions, il faudrait admettre que le sol, en tant que corps naturel formé sous l'influence des agents atmosphériques et biologiques, n'existe pas.

Quelle que soit l'importance du facteur géologique, qui fournit la matière première pour l'édification de tous les sols, il faut cependant convenir qu'à lui seul, il constitue une base trop étroite pour leur classification.

Même dans un pays comme la France, où les différences climatériques ne sont pas très grandes, il y aura encore lieu d'en tenir compte suivant leur degré d'influence sur la décomposition physique, chimique et biologique des roches-mères.

C'est seulement en procédant de cette manière qu'on pénètre dans la véritable philosophie de la formation des sols et des propriétés générales qui les différencient.

La carte agronomique, dit le professeur Agafonoff, doit être construite d'abord sur le principe des zônes climatériques. Après cela seulement les types zonaux de sols seront divisés en sous-types basés sur les autres caractères (gèologiques, physiques, chimiques, etc.)

Une telle carte répondra aux exigences de la science actuelle, et, après son développement ultérieur, pourra servir de base à l'évaluation des terres (10).

Le même auteur estime aussi que malgré que les différences climatériques soient moins nettement marquées en France que dans d'autres pays, tels que la Roumanie et l'Espagne, par exemple, on pourrait y faire la distinction entre quatre types zonaux de sols. Une autre difficulté pour l'application des principes de classification de l'école russe, un pays comme la France, occupé depuis si longtemps et sur presque toute sa surface par la culture, c'est d'y retrouver les profils naturels typiques des sols. Il est évident, en effet, que le travail répété de la couche arable détruit constamment la partie supérieure du profil. Dans ces conditions, il devient difficile d'en retracer la structure et les relations du sol avec la roche mère.

En France, on ne retrouve des sols naturels que dans les forèts ou dans certaines régions incultes telles que les Landes.

Cependant, il y aura à tenir compte que les couches un peu profondes des espaces cultivés n'ont guère été modifiées par les façons du sol; elles fourniront généralement encore assez d'indications pour la reconstitution du profil caractéristique.

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Activités des Sections.

Section de Sainte-Anne de la Pocatière

Le 30 septembre 1926, la section de Ste-Anne des Agronomes Canadiens se réunissait pour élire un nouveau Président en remplacement de Monsieur R. P. Charbonneau. Cette réunion eut lieu à l'occasion de l'Exposition de chevaux tenue à l'Ecole d'Agriculture.

Monsieur D. Fortin, Vice-Président, après avoir souhaité la bienvenue à tous, annonça l'élection et expliqua les trois manières d'y procéder. Le vote au bulletin secret, sans avoir à désigner aucun candidat à l'avance, fut adopté. Messieurs Bourgault et Baribeau se chargèrent du dépouillement du scrutin, lequel amena Monsieur J. A. Ste. Marie, Régisseur de la Station Expérimentale de Ste-Anne de la Pocatière, à la Présidence.

Le nouveau Président remerçia l'assistance de l'avoir placé à ce poste d'honneur et de confiance, et insista pour avoir des réunions plus fréquentes; il proposa aussi d'établir une coopération plus étroite et plus féconde entre ceux qui s'occupent d'agriculture, afin que, tous, nous puissions mieux nous rendre compte du travail accompli dans chacune des différentes sphères de l'activité agricole.

Le Président sortant, Monsieur R. P. Charbonneau, Propagandiste pour l'Association des Eleveurs de Holstein, qui, par une heureuse coincidence, assistait à la réunion, voulut bien se rendre à l'invitation de Monsieur Ste-Marie et adresser quelques mots. Mons. Charbonneau nous dit le plaisir qu'il avait d'être au milieu de nous ce soir et de constater avec quel enthousiasme nous voulions marcher de l'avant et faire notre bonne part comme membres de la Section de la Société des Agronomes Canadiens.

Ensuite Mons. Godbout traita avec beaucoup de tact la question des réunions futures et nous fit remarquer que nous sommes capables de préparer un travail très intéressant pour chacune de ces réunions. Mons. Sirois partage les vues de Mons. Godbout et dit qu'il est certain qu'en variant nos réunions nous les rendrons plus intéressantes. Monsieur Racicot nous dit quelques mots sur la question des bourses accordées aux gradués en agriculture et fait remarquer que ceux qui désirent se spécialiser en pathologie végétale doivent avoir un haut degré d'entrainement professionnel et des connaissances très approfondies sur la chimie. Sur la demande de Mons. le président, Mons. Gagné, Professeur, nous explique les différents genres de bourses et la manière dont elles sont accordées.

Mons. D. Fortin, Président actif, remercie l'assemblée en formulant les voeux d'avoir dans un avenir assez rapproché, une réunion dans le bas de Québec afin de permettre à nos confrères éloignés de se joindre à nous.

Section de Montréal

La section montréalaise de la C.S.T.A. a organisé le premier diner-causerie de l'exercice en cours, le samedi, 2 octobre, à l'hôtel du Cercle Universitaire de Montréal. Ce jour nous cumes le plaisir de recevoir, en qualité d'hôte d'honneur, le Dteur Creelman, président général de la C.S.T.A., qu' accompagnait le sympathique secrétaire général de notre société, monsieur Fred. H. Grindley.

Le Dteur Creelman, présenté par H. M. Nagant, président de la section de Montréal, adressa le premier la parole aux convives. Il sut faire ressortir, avec beaucoup d'éloquence et une ferme conviction, l'importance de notre association professionnelle, qui est actuellement la plus forte qu'il connaisse dans son genre, nous dit-il. Pas un technicien agricole du Canada ne devrait manquer d'en faire partie, telle est la conclusion de l'orateur. Le poids de pareilles affirmations venant d'un homme qui, pendant 16 ans, fut président du Collège d'Agriculture d'Ontario et durant ce temps, eut l'occasion d'étudier les principales institutions agricoles du monde visitées au cours de ses voyages à travers tous les continents, n'a pas besoin d'être souligné.

Monsieur J. N. Ponton, ancien élève et gradué de Guelph, répondit en quelques phrases bien tournées à l'allocution du président général de la C.S.T.A.

Le conférencier du jour fut monsieur H. M. Nagant, qui donna un résumé de l'étude paraissant actuellement dans la "Revue agronomique canadienne", sous le titre de: "Conceptions récenter en matière de classification des sols."

Monsieur Gustave Toupin adressa der remerciements au conférencier, au nom des membres présents.

H. M. N.

A la Mémoire de Monsieur Marsan.

Le 28 septembre dernier, par une radieuse matinée d'automne, le buste du regretté monsieur I. J. A. Marsan, Docteur en sciences agricoles, nous est apparu sur son socle de granite, érigé devant la façade du séminaire de l'Assomption, où, sous l'ombrage des arbres qui semblent lui faire une garde d'honneur, il rappellera aux générations présentes et futures la mémoire d'un véritable homme de bien. Il faisait un temps tel que l'aimait précisément monsieur Marsan pour entreprendre quelque longue course à travers les campagnes et les bois, resplendissants dans leur parure du déclin. Les circonstances me faisaient penser aussi à l'une de ces promenades en sa paternelle compagnie, il y a une dizaine d'années de cela, à l'orée des bois du Calvaire d'Oka, dont le feuillage fulgurait dans toutes les gammes de l'empourprement.

Le vieillard, bien que très alerte encore, songeait au fantôme de la mort qui l'approchait lui aussi comme cette admirable nature d'automne dont il ne pouvait assez s'emplir les yeux, et avisant un de ces blocs erratiques, échoués en cordons au pied de la colline, dont les cristaux de labradorite tout chatoyants sous les rayons directs du soleil avaient attiré son regard, il me dit: J'aimerais avoir sur ma tombe un mausolée taillé dans une de ces roches que les glaciers du nord ont laissé choir dans nos champs, au terme de leur long voyage.

A une des réunions de la section de Montréal de la C.S.T.A., qui suivit la mort du regretté monsieur Marsan, cette réflexion fut rappelée. Aussitôt, l'un de nos amis de proposer de s'unir pour remplir comme un pieux devoir le désir exprimé, en chargeant un tailleur de pierre de façonenr un de ces bloes, choisi à Oka, pour le placer sur la tombe du vénéré disparu. Tel fut, je crois, l'origine modeste du projet de monument Marsan, lequel, repris aussitôt avec une amplitude croissante, par la foule de ses admirateurs parmi les agronomes de la province de Québec, devait aboutir à grande apothéose du 28 septembre dernier, en face de laquelle la modestie du héros se serait révoltée, s'il avait pu concevoir le moindre soupçon de ce qui l'attendait.

Les orateurs de la mémorable journée du dévoilement ont trop bien fait ressortir et célébré les mérites de l'homme que l'on honorait, pour que nous répétions, ici, ce qu'il y aurait à en dire; contentons nous de résumer fort brièvement ce concert d'éloges en affirmant que monsieur Marsan était comme la cristallisation de ces vieilles vertus familiales et civiques, d'honnêteté, de droiture, de dévouement et d'abnégation, jaillies d'un fond profondément chrétien, qui de génération en génération se sont transmises dans les meilleures familles de cette vaillante race bourgeoise et paysanne du vieux sol de France et ont continué à fleurir de plus belle sur le rameau implanté au bord du St-Laurent. Aussi peut-on dire tout d'abord que la grandiose manifestation du 28 septembre revêtait une haute portée morale, en reconnaissant et honorant, en la personne de monsieur Marsan, ces vertus que la génération actuelle avait peut-être une tendance à mépriser parce qu'on leur rend trop rarement ou trop tardivement l'hommage et la récompense qu'elles méritent.

Ajoutons aussi que le tribut d'hommage déposé au pied du monument de l'Assomption dépasse ou plutôt déborde le personnalité de M. Marson. Il consacre et reconnait publiquement, et cela d'une manière éclatante et solennelle, par les hautes personnalités qui y présidaient, la grande valeur pour le pays, le rôle considérable dévolu à toute une classe professionnelle, de formation récente, celle des techniciens agricoles, dont le vénérable Dr. Marsan fut un des précurseurs les plus méritants, qui sut, avec un courage et une dignité à toute épreuve, en arpenter les chemins ingrats et raboteux, à une époque où elle était complètement ignorée.

H.M.N.

NOUVELLES DE NOS MEMBRES

On nous informe que monsieur Richard Bordeleau, B.S.A., de la promotion de 1924, à l'Institut Agricole d'Oka, vient d'être nommé Assistant-Agronome dans le comté de Terrebonne, avec résidence à Ste. Thérèse.

Monsieur Roméo Cossette, Assistant-Régisseur de la Ferme expérimentale fédérale de Farnham, a accepté la position de régisseur des propriétés de monsieur Brunet, à St. Jean d'Iberville.

Concerning the C.S.T.A.

THE PRESIDENT VISITS QUEBEC

Dr. G. C. Creelman, President of the C.S.T.A., accompanied by the General Secretary, paid a visit to the French sections of Quebec during the first week of October. He addressed members of the Montreal branch on Saturday, October 2nd, and the members of the Quebec City local at a dinner on Monday, October 4th. He also spoke to the student body of the Oka Agricultural Institute on Wednesday, October 6th.

On Sunday, October 3rd, Dr. Creelman inspected the monument recently unveiled at L'Assomption, P.Q., to the memory of Dr. Marsan, formerly Professor at the Agricultural School at L'Assomption and at the Oka Agricultural Institute, who died in 1924. The funds required for the designing and erection of this monument, exceeding $5,000.00, were collected by a committee of the C.S.T.A. in Quebec, and the monument will stand as a permanent record, not only of the work of Dr. Marsan, but also of the esteem in which he was held by the technical agriculturists of his native province.

THE MEMBERSHIP CAMPAIGN

About October 10th a Dominion-wide membership campaign was launched by Dr. Creelman, when an illustrated folder was mailed to all non-members in Canada whose addresses could be located. At the time of writing (October 22nd) it is too soon to predict results, but it is confidently expected that the total membership will reach one thousand before Christmas. Any members who can assist in this campaign are urged to do so.

NOTES

E. G. Booth (Saskatchewan '21) is taking graduate work in plant breeding and physiology, towards the degree of Ph.D., at the University of Minnesota.

G. T. Jackson (O.A.C. '25) is Manager of Caulder's Creamery at Outlook, Sask.

H. M. Tysdal (Saskatchewan '24) has recently changed his address from the Kansas Agricultural College to the Dept. of Agronomy, University Farm, St. Paul, Minn. Presumably he is taking graduate work.

J. A. Steele (O.A.C. '20) is now a dairy promoter under the Dominion Live Stock Branch, with headquarters at Lawrencetown, N.S.

W. Newton (Macdonald '14) is Assistant Professor of Biology at the University of California, Southern Branch, Los Angeles.

The Fall meetnig of the British Columbia local is likely to be held at Victoria, B.C., on November 25th, during the Provincial Potato Bulb and Seed Show.

A joint banquet of the four Quebec branches is being held in Montreal on November 2nd, during the week of the Apple Show. The principal speaker will be the Honorable J. E. Caron, Minister of Agriculture for Quebec.

The three Maritime province locals are also holding a joint dinner at Amherst, N.S., on November 2nd, during the Amherst Winter Fair.

The organization meeting of the Eastern Canada Society of Animal Production will be held at the Prince George Hotel, Toronto, on November 17th. Invitations have been sent out to all those who might be interested. The Organizing Secretary is Mr. L. C. McOuat, Dominion Live Stock Branch, Ottawa.

It is expected that a classified list of C.S.T.A. members will be published in January next, and distributed free to members. All those who join the Society prior to December 31st, 1926, will be included in the published list.

The Soil Survey in Southern Ontario.

G. N. RUHNKE

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Recognition of differences in the productiv- of different kinds of soils and their classi- tion on some such basis is by no means ecent feature of agricultural development. en nomadic man first began to cease his iderings and establish himself in one ce, he had of necessity to select a site which food for himself and his flocks ld be grown easily, and in abundance. And long as there were vast areas of land un- upied and unsettled, the problem of select- a suitable location was an easy one. When began to gather together in clans and es, and the size of their flocks increased, best available lands in the country were n taken up and the question of selection and became a more critical one than ever.

he earliest reported consideration of the erences in agricultural value of soils, is nd in supposedly authentic records of the iculture of China(1), about 2356 B.C. ing the regime of the Yao dynasty, a per- in which China made her greatest pro- s and certainly greatest agricultural ex- sion, the Emperor caused to be made what in principle and effect, the first soil sur- . This was brought about by the fact certain parts of the country were at that e very thickly settled and apparently in ger of becoming overpopulated. As a ilt of this survey, the soils of what was known as China, were divided into nine ups according to their agricultural value their crop adaptations. On the basis of survey there was determined the size of holding of each farmer, the amount of s payable to the state and a system of cultural education was worked out, which ed a great part in the prosperity and ansion of the nation, which marked its elopment for the next four centuries.

he writings of the ancient philosophers full of references to the need for selecting soil as suited to the crop, and so on down ugh the history of agriculture until re- times when we have the same idea ked out in all its possibilities, in the lern soil survey.

In the United States, the classification and mapping of soils has been going on for at least twenty-five years. In some of the States, it is possible to obtain detailed soil survey reports containing soil maps and descriptions of the agriculture and soils, for three quarters of the counties in the State. As a branch of the activities of the United States Department of Agriculture, the soil survey as conducted by the Bureau of Soils is an established feature of agricultural development in the same class with the improvement of crops, livestock, etc. With them it has become the fundamental basis of their various phases of soils investigation.

The Soil Survey in Ontario, still in its youth, is naturally not so well known. On first consideration, the question may arise as to why a soil survey is needed in an old settled province such as Ontario, where the soils and their characteristics have been studied in a large degree through long practical experience of our agriculturalists, and where practically all of the land of agricultural value is now under cultivation.

But if we consider that in such a region, we have a wide variety of soils, and more specialized cropping in many sections of the province is rapidly coming about, we have an acute problem in the form of determining the most profitable agricultural utilization, for each of our soil types. This latter problem necessitates an intimate knowledge of the soil, which infers the need for identification of the soil type according to its inherent properties, both physical and chemical, and its adaptability for certain crops.

Continued cropping of these older cultivated areas has resulted in a decrease in production which is especially marked on some types and has necessitated an immediate study, of methods of restoring in so far as possible, the fertility of these depleted soils.

Coupled with the economic need, from a purely scientific aspect, we need to know more about our soils and the changes they are undergoing, if we are to keep abreast of

the progress in soil science in other countries. As yet this is a field in Ontario that has been explored only in the most elementary way.

Progress of the Survey in Southern Ontario

In order that the reader may have a clearer conception of the present status of the Soil Survey work which is being done through this Department, brief reference will be made to the progress of the work since it began some twelve years ago.

Early in 1914, Professor Harcourt, who had been in touch with the survey in United States, invited Dr. Coffey of the Ohio Department of Agriculture, previously of the Bureau of Soils, at Washington, to come to Guelph and assist in the commencement of the work in Ontario. Mr. A. J. Galbraith, then of the Department of Chemistry at the Ontario Agricultural College was chosen to do the field work, and had the benefit of Dr. Coffey's assistance and advice for the first month's work that year. He continued the survey the following year, but since the work was new to him and the c fication of the soils in the tentative s early progress was slow.

During the next two years the survey carried on by Mr. A. C. Woodard ar 1918 was taken over by the late W. L. son. The latter correlated the work dor his predecessors, extended the area u survey, and accumulated a large amou data on our soils in the three years the was in his charge. Unfortunately, Mr. son died suddenly in the winter of 192C fore he was able to publish the result o investigations he had carried on. For succeeding years no field work was atte ed, but the analysis of the soil samples iously taken was carried through to pletion.

In the summer of 1922, it was the wr privilege to spend the season studying survey methods in New York State u Prof. F. B. Howe of Cornell University, the following year, to take up the soil vey of this Department from where it stopped in 1920.

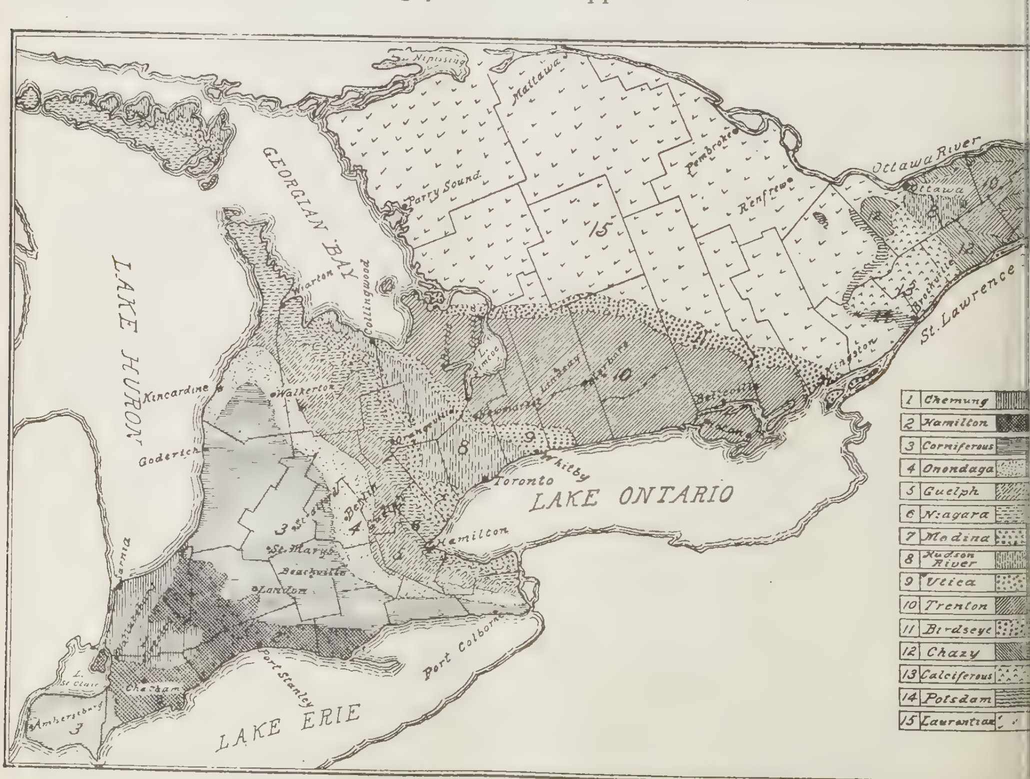

Figure I.

During the summer of 1923 the first pub-
:ation of a soil survey report appeared in
illetin 298, "Preliminary Soil Survey of
uthwestern Ontario," which comprised the
sults of all the work done on the recon-
isance survey previous to 1920.

With the preliminary survey as a basis,
il fertility experimental plots were locat-
on some of the more important soil types.
ie first of these, started in 1915, was nat-
ally the Guelph Plot on the College Farm.
is plot of three acres is representative of
important and extensive type of soil,
ssified as the Guelph Loam. The second
ot to be established was that located just
tside of the town of Simcoe in Norfolk
unty, on a light, coarse, open soil, classi-
d as a Dunkirk Sand. This plot consists
six acres and originally was typical "blow
id" soil so extensively developed in Nor-
k County.

In 1920 another plot was established about
e and one-half miles from Welland, Ont-
o, on the Niagara Falls Road. This plot
isists of twenty acres of soil classified as
Haldimand Clay; a heavy compact im-
rvious clay, with poor natural drainage,
resentative of this extensively developed
e, common to our glacial-lake soil areas.
ice one of the most urgent needs of this
l type is underdrainage, fifteen acres of
s plot were underdrained according to a
nplete drainage scheme drawn up by the
ainage Department at the College, and five
es were left undrained, for comparison.
ace does not permit a description of the
n of experiments conducted on these plots.
r such information the reader is referred
the afore-mentioned Bulletin 298, which
cusses this matter in some detail.

Following up the preliminary surveys, de-
l surveys were planned for areas where
ensive agriculture, and tendency to special-
d cropping indicated an immediate need
more information on the soils in these
alities.

Since 1923 detailed soil surveys have been
de of Kent County, the Niagara fruit belt,
low the escarpment from Hamilton to the
agara River,) Essex County, and this past
son we have begun a survey in the county
Norfolk which we hope to complete in
27.

Besides the mapping and studying of field
racters of the soils in the above areas, several hundred samples representative of the important soil types have been analyzed to determine differences in their chemical composition.

This data coupled with that obtained from the preliminary and detailed surveys has given us much valuable information concerning our Ontario soils without which we should not be so well equipped to cope with the numerous soil fertility problems which we have undertaken to study.

Geological Relationship of Southern Ontario Soils

In order that a proper appreciation may be had of the nature of the soils in Southwestern Ontario, it is necessary to consider the related geological factors operative in their formation and development. The whole of the Province has been somewhat severely glaciated and hence the soils in this area are developed from glacial ice and glacial water laid deposits. As would be expected wide variations in texture result, so that we have a range from the heaviest of clays to the lightest of wind blown sands.

Before proceeding to the discussion of the major division of soils, however, some consideration is due the parent rocks from which the glacial material was eroded and transported. The accompanying map (Fig. 1) shows the underlying rock formations and their approximate location and extent in the area surveyed.

In southwestern and central Ontario a part of the soil material is of granitic origin brought down from the Laurentian Plateau by the ice sheet. The greater part, however, came from the underlying rocks, the limestones, sandstones and shales.

The movements of the ice sheet in this region was not uniformly in one direction as the ice took on a distinctly lobate form.(3) One lobe occupied the basins of Georgian Bay and Lake Huron known as the Huron Lobe, the other occupied the basins of lakes Ontario and Erie, and is known as the Erie Lobe. (4) While the general movement of these two lobes was in a southwesterly direction, local movements or oscillations took place which were far more important in the modification of topography and the deposition of soil material. These local movements combined with the variety of rock

formations exposed to the eroding action of the glacial ice, are largely responsible for the heterogeneity and complexity of our soils in this area. Some idea of the local directional movements may be obtained from the accompanying map of terminal moraines by Taylor. (Fig. 2.) One of the most noticeable features of the moraine system is the somewhat elliptical shaped area lying in a northeast direction from London. This area was covered by the ice sheet for a relatively short time and hence is marked by a less rugged topography than is true of the terminal moraine areas.

Area Covered by Glacial Lakes[4]

Contemporaneous with the melting of the ice sheets there were formed great glacial lakes which during the various stages of their existence occupied the basins of the present great lakes and a considerable marginal belt of the present land surface. In the accompanying illustration (Fig. 3) the approximate margins of the glacial lakes are shown, which varied with the level of the waters due to advance or recession of ice. Within the areas of these glacial l the soil materials for the most have vigorously reworked, sorted, transported re-deposited by the water action. Soil heavy texture, compact structure and cient drainage are of frequent occurr where the glacial material was of cl nature. On the margins of these lakes w beaches and bars were frequently for where alluvial fans were swept out by land streams which emptied into these g ial lakes, soils of coarse open texture, oxidized and well drained are usually dominant. Some of this material, of sandy texture, during the period of ari which succeeded the glacial age, was tr ported and redeposited by the action of wind and we have soils of the loessal occurring in some parts. Where term moraines have been deposited within areas subsequently occupied by glacial wa the moraines have been reworked and materials deposited in well sorted and st fied layers. The soils developed on t

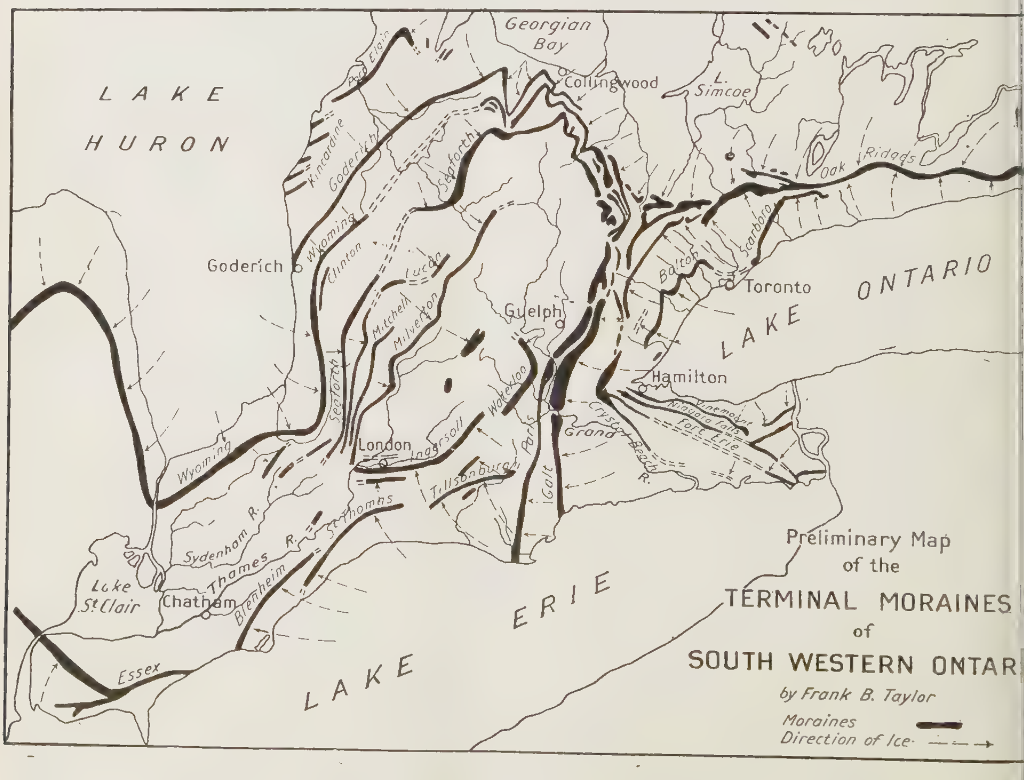

Figure 2.

water laid moraines do not differ essentially from the soils developed from true marginal glacial lake deposits.

Classification of Ontario Soils

The soil survey work done to date has been based on the United States Bureau of Soils Classification. Our soils are divided into two soil provinces, the Glacial Drift Province and Glacial Lake Province. These provinces are further sub-divided into groups based on differences in the origin of the parent material. Thus we have our limestone and crystalline rock groups, sandstone and shale groups, in both the drift and glacial lake provinces. Further subdivisions based on colour, drainage and topography, result in "series" within the groups and the series are further subdivided into types, based on textural differences.

There has been a tendency among soil surveyors to make rather fine distinctions on the basis of textural and other differences so that in some areas the classifications have become rather unwieldy and of little value from a practical agricultural standpoint. In the work done by this Department, the aim has been to keep the classification as simple as is possible and emphasizing distinctions in soil types, where differences in agricultural value and crop adaptations were of economic significance.

In the last three or four years, noticeable attention has been drawn to the profile method of classification and study of our soils. There is no doubt that a classification based on the definite properties of the soil itself is more valuable than a classification which is based primarily on outside influences and forces, operative in the development of the soil. This, the profile basis of study has been devised to overcome and as such is a distinct advance in soil study. However, in view of the fact that the new classification is yet in the tentative stage, and also that a vast amount of valuable soil survey work has been done on the basis of the former classification we have deemed it advisable

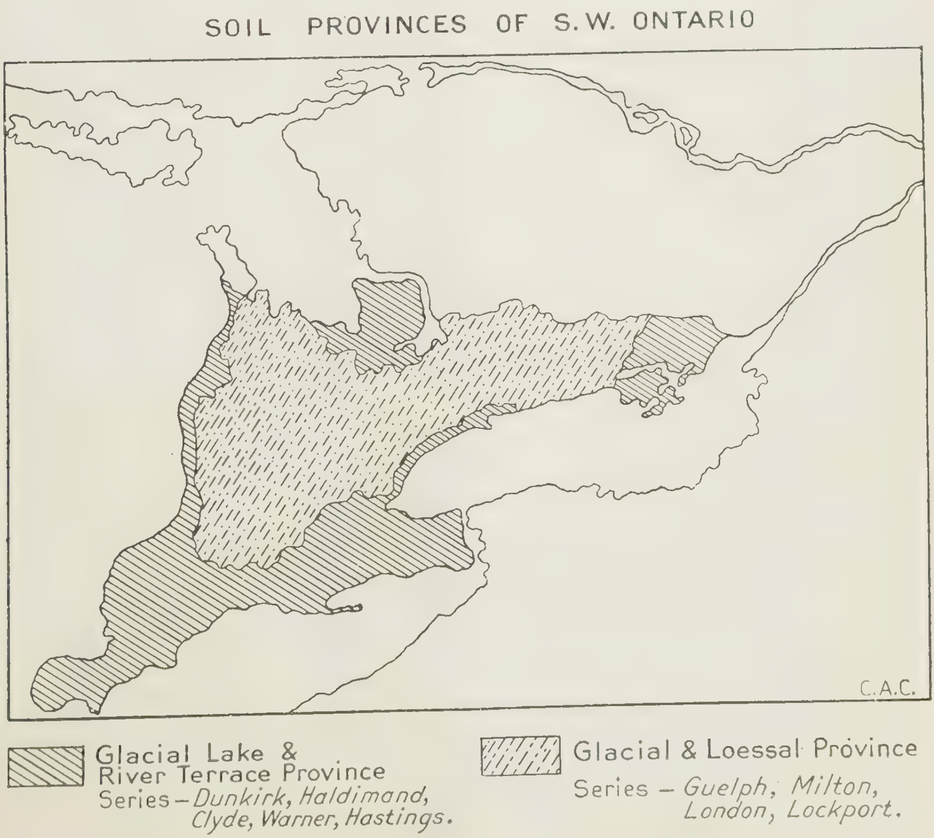

Figure 3.

to adhere to the present classification in our field work and mapping. At the same time, nevertheless, we are applying the profile method of study to our soils and gathering data for this purpose along with the regular work of the soil survey. There is no doubt that from a pure science standpoint this latter information is essential, but our first obligation seems to lie in the direction of a field study, that embraces consideration of the practical agricultural viewpoint.

Chemical Composition of Representative Soil Types

In table No. 1, the chemical composition is given of representative samples of a few of the more important Southern Ontario soil types. These analyses were made by the fusion method and are calculated on the air dried basis. The samples which were taken earlier in the work of the survey have been taken on the arbitrary depth basis. At the present time samples are taken on the horizon basis having the respect for color changes in the soil profile. Our recent analyses made of samples taken on this basis are reported for the various horizons of the profile instead of for arbitrary depths.

Table No. 2 gives the partial composition of representative samples of surface soils taken during the survey of the Niagara Fruit Belt. The determinations have been by fusion method and are for surface soils only.

Economic Importance of the Survey

Elsewhere it has been stated that in this work we have stressed the economic phase of the survey and in support of this, the writer wishes to quote three marked soil type and crop relationships observed in the course of the making of some recent detailed surveys.

In the Niagara fruit belt the ideal soil type for commercial peach growing is the Dunkirk fine sandy loam (deep phase) so typically developed in the vicinity of Grimsby

TABLE NO. 1

Soil Type		% Loss on Ignition	%N	$\%P_2O_5$	$\%K_2O$	%CaO	%MgO
Guelph Loam	Surface*	3.96	.051	.220	2.42	11.23	7.23
	Subsurface	2.05	.181	.223	2.00	1.94	0.66
	Subsoil	1.78	.051	.209	2.01	2.17	1.08
Guelph Stony Loam		4.51	.014	.220	2.18	2.60	1.45
		4.12	.205	.335	2.26	1.38	1.23
		3.57	.051	.222	2.49	2.23	2.18
London Silt Loam		6.43	.031	.223	2.62	2.89	2.30
		4.42	.182	.136	2.32	1.69	1.34
		3.72	.061	.188	2.29	2.05	2.21
Milton Loam		7.22	.041	.237	2.57	2.38	2.43
		6.55	.253	.196	2.83	4.85	1.46
		4.84	.134	.200	2.70	4.29	2.48
Clyde Clay		2.87	.050	.129	2.26	4.32	2.52
		2.22	.151	.220	2.05	2.58	1.42
		2.46	.040	.212	2.15	2.47	1.51
Clyde Sandy Loam		9.55	.041	.238	2.37	2.51	1.94
		6.04	.351	.254	2.30	2.46	1.98
		5.18	.134	.243	2.43	6.06	2.50
Haldimand Clay		5.29	.072	.245	2.56	9.01	2.65
		2.83	.205	.277	2.18	3.79	1.32
		3.20	.051	.263	2.44	2.64	1.27
Dunkirk Loam		12.12	.041	.271	2.99	2.45	2.46
		8.20	.354	.228	3.43	3.87	3.73
		5.59	.179	.199	3.07	6.69	5.65

*Surface soil depth 0"—$6^2/_8$"
Subsurface soil depth $6^2/_8$"—20"
Subsoil soil depth 20"—40"

TABLE NO. 2

ANALYSES OF REPRESENTATIVE NIAGARA FRUIT BELT SOILS

Depth of surface according to type.

Type	N.%	P_2O_5%	CaO%	MgO%
Dunkirk f. s. loam	.16	.141	1.14	.55
Dunkirk f. s. loam	.11	.109	1.03	.98
Lundy silt loam	.10	.123	.77	.74
Clyde f. s. loam	.42	.181	1.20	.34
Clyde cl. loam	.35	.108	.98	.79
Niagara stoney loam	.16	.078	.61	.70
Lockport silty clay	.18	.079	.477	1.02
Dunkirk f. s. loam (shallow phase)	.15	.096	1.21	.61
Dunkirk stoney gr. loam	.16	.246	4.98	.67
Iroquois gr. s. loam	.15	.107	1.18	.84

:his soil is a grey brown to yellow brown, ine sandy loam in the surface averaging bout 8 to 10 inches in depth underlain with light yellow brown to golden yellow fine and or fine sandy loam of uniform color, a depth of 24"--30" grading into a yellow ray or gray sandy loam to sand. Below his, stratified sands and sometimes very fine ravels persist for considerable depth. This oil is relatively speaking naturally very well rained, well aerated (as its color would ndicate) and is a deep soil.

Associated with it, is the Dunkirk fine andy loam (shallow phase) which has es- entially the same color in surface and sub- oil but differs markedly in depth. The shal- w phase, as mapped on the soil survey con- ucted in the Niagara district in 1924, was rdinarily 3 feet or less in depth and under- in, by a heavy compact impervious boulder ay. This impervious substratum holds up e water table to such a point that the sub- oil has more or less of a perennial water- gged condition present.

Peach trees will not tolerate cold wet sub- ils and hence in having their root systems stricted to a shallow surface layer of the il they do not make normal development such a soil as the Dunkirk shallow phase ie sandy loam.

The writer observed several young orchards anted out on this soil type, which at that ne had reached bearing age but had failed her to produce fruit at all, or if fruit is produced it was in such small quantities d of such poor quality as not to warrant ndling.

In each case observations showed that other factors such as care of trees, spraying, pruning, cultivation, etc., had not been neglected yet in spite of this, these orchards did not thrive on this soil.

Now to the casual observer, who does not investigate the depth of the soil, nature of the subsoil, etc., the shallow and deep phase Dunkirk fine sandy loam appears to be one and the same soil. There is a grave danger that the uninitiated may be led to purchase inferior land of this type on the supposition that it is good peach land, and set out an orchard upon it. Unfortunately, it is possible that five or six years must elapse before he discovers that the soil is not suited to peaches at all and he suffers considerable loss in the capital, labor and time invested in such a worthless proposition.

Such distinct relationships have been emphasized by Hall and Russell(5), Wilder (6) and Cosby (7) in connection with fruit soils in areas which have been surveyed. Undoubtedly future studies of our fruit soils in Ontario will reveal further important relationships between varieties of fruit grown and nature of the soil types.

A second instance of a crop and soil relationship has been especially noticeable in connection with the well known raspberry soil of the Waterford District in Norfolk County, Ontario. Waterford raspberries widely recognized as being of superior quality to berries produced in other districts, are grown to perfection on a distinct type of soil which is distinguished by its high content of micaceous material. Ideal conditions of

moisture supply seem to be present, for even in seasons of marked drouth, when raspberries on other soils are markedly affected, those grown on the Waterford soil are of excellent flavor and quality. Of course it must not be assumed that raspberries represent the only crop grown in this soil; truck crops are grown in abundance too, but this district is acknowledged by growers of long experience to be eminently superior for raspberry culture.

A third important adaptation of crop to soil has been in connection with the extension of the flue cured tobacco growing areas in Elgin and Norfolk Counties. The quality of flue cured tobacco is greatly influenced by the type of soil on which it is grown, and color and the texture of the soil seem to be of the most important factors in this connection. The experienced flue cured tobacco grower is able to identify a suitable soil at a glance and his judgment is based almost entirely on the color and the "feel" of the soil. Such soils, however, are distinctly different from associated soils and these differences while not apparent to the uninitiated are nevertheless distinct and of great importance in the selection of a site for the growing of this type of tobacco.

The quality of leaf determines the price paid for tobacco and under present conditions there is little or no market for a poor quality or inferior product. Since the soil plays such an important part in determining the quality of this crop, the identification, mapping and study of such soils is of very great importance. With such information available, there is less liability of the prospective tobacco grower making an extensive investment in unsuitable land, which must certainly result in great financial loss.

In our soil survey work we are making careful distinctions between soil types on the basis of important crop and soil relationships such as those which have been described. At the same time we are not neglecting the purely scientific aspects of th field study of soils. Since all agricultura research work in the Province is apt to b scrutinized from the standpoint of its economic value, we feel that the determinatio of the proper utilization of our soils, b crops for which they are best suited, is on of the most important features of the ap plication of the Soil Survey in Souther Ontario.

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Growing Wheat and Barley Hybrids in Winter by Means of Artificial Light.*

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Introduction

From the viewpoint of the plant breeder, it ould be often advantageous to hasten the ogress of new hybrid material by growing e or more of the early generations in the eenhouse during the winter months. This s attempted successfully during the winters 1924-25 and 1925-26 in the University eenhouse at Saskatoon, Saskatchewan, ough the use of artificial light as a supple-nt to the natural daylight.

A number of investigators have studied e effects of light duration and intensity on plant growth during the past forty rs. One of the conclusions of Garner and lard (1 and 2), who experimented with a ge number of plants, was that "in all spec- thus far studied the rate of growth is ectly proportional to the length of the ly exposure to light". Wanser (3) found t the regulation of the daily exposure to ht of winter wheat plants made it possible induce the jointing and heading stages espective of season. Harvey (4) grew sev-l varieties of wheat, oats, barley, rye and er common crops from seed entirely by tinuous artificial light. Spring wheat duced ripe seed in about 90 days. Coop- (5) states that a crop of grain can be tured during the shortest days of the year using artificial light to lengthen the daily ation of light. Adams (6 and 7) work- with 16 species of plants including wheat, and flax, found that the rate of growth promoted and the time of flowering ac-rated by the addition of nightly illumina-. Hendricks and Harvey (8) recently e investigated the intensities of light re-red for blooming. They grew 41 spec- of plants under artificial light and found erent species varied considerably in their uirements. Common and durum wheat barley bloomed and produced seed at to 800 foot candles, but oats required . Some plants showed growth and oming at a large range of intensities, le others were found to bloom only at a limited range. In the plant breeding work at the University of Minnesota, wheat hybrids have been grown from seed to maturity in the greenhouse through the use of artificial light.**

Artificial light was employed by the writer chiefly for the purpose of hastening the progress of certain wheat crosses by growing the first hybrid generation in the greenhouse during the winter. Owing to the high latitude of Saskatoon, the days from November 1st to February 15th are quite short. During much of this period the temperature is below zero Fahrenheit and a thick coating of ice that forms on the greenhouse glass prevents a large part of the sunlight from passing through. As a result of these conditions most cereals cannot be grown during the winter with any degree of success without the use of artificial light.

An attempt was made to grow two successive grain crops in the greenhouse between September 15th and May 1st in order to utilize the greenhouse equipment as efficiently as possible. In addition, some work was done to determine the amount of artificial light required, and to furnish answers for several other problems that arose.

Materials and Methods

Well known varieties of wheat, oats, barley and rye and certain wheat and barley hybrids were used. They were planted in the greenhouse in eight and nine inch pots, three and four seeds, respectively, to each pot. The first crop was sown October 15, 1924, and consisted of 150 F_1 plants of Marquillo x Marquis, Velvet x Hannchen, several other wheat hybrids, and 30 plants of several varieties of wheat, oats and barley. The second crop was planted January 4, 1925. In addition to wheat and barley

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** Results of the Plant Breeding Department, University of Minnesota, St. Paul, Minnesota.

hybrid material, Marquillo and Marquis wheat, Velvet and Hannchen barley and Black Tartarian, Victory and Liberty oats were planted for the purpose of making crosses in the greenhouse. On September 12, 1925, 60 F_1 seeds of Marquillo x Marquis were sown. Another 600 seeds were sown on October 1, 1925. This material consisted of eight different wheat crosses, the parental varieties and several other varieties of the small grains. On January 15, 1926, a planting of 600 seeds of wheat hybrids, and some barley and oats was made.

The environment was made as much like normal field conditions as possible. The soil used for the 1924-25 plantings was a mixture of well rotted sod and manure with sand in the proportions of 3: 1. The 1925-26 mixture consisted of rich top soil, well rotted manure and sand in the proportions of 2: 1: 1. The plants were watered whenever the soil became somewhat dry, which was about every two days. Heat was furnished by steam pipes and the electric lights. T perature was controlled by means of regu ing the amount of steam and by open skylight ventilators.

During the growth of each winter cro was necessary to dust the plants occasion with flowers of sulphur to control mild of which a trace was present. Aphids w controlled by fumigation with "nicofu every ten days to two weeks.

During the winter of 1924-25 a sin 1000-watt 250-volt nitrogen lamp with deep bowl reflector furnished the artifi light. Fourteen 300-watt 120-volt nitro lamps with deep bowl reflectors were add in 1925-26. For all of the crops the 10 watt lamp illuminated 30 square feet greenhouse bench. The 300-watt lamps e illuminated nine square feet of bench. 1924-25 there was essentially the same m agement of artificial light as in 1925- which was as follows:

Date Planted	Date Harvested	Period during which light was supplied artificially.	Hours during which light was plied artificially each day.
September 12th and October 1st.	January 4th	October 16 to November 12 November 13 to November 26. November 27 to January 4.	5.30 P.M. to 10.45 P.M. 5.30 P.M. to 1.30 A.M. 5.00 P.M. to 9.00 A.M.
January 15th	May 10th	February 13 to March 8. March 9 to March 22. March 23 to May 1.	5.30 P.M. to 10.45 P.M. 5.30 P.M. to 1.30 A.M. 5.30 P.M. to 4.15 A.M.

Results

Because of unavoidable accidents the results for the September and October plantings were less successful than was expected. However, the January and February plantings were quite satisfactory. The wheat that was sown on October 15th, 1924, was harvested February 1, 1925. The plants yielded from one to four seeds each. The barley of the same planting ripened during the last ten days of January with a seed setting of nearly 100 per cent. The February 4, 1925, planting ripened during the last week of April and the first week of May. The wheat and barley set between 90 and 100 per cent. of seed. The wheat and barley crosses were as successful in the amount of seed set as crosses made in the field nursery. The oat varieties yielded very few seeds and the oat crosses but one seed out of twenty pollinated florets. The plants attained a fair growth but failed t produce healthy anthers.

During the winter of 1925-26 two succes sive crops of grain were produced in t greenhouse. The September 12th planti headed between November 23rd and the 28 and ripened during the first three days January. The seed setting averaged over per cent. (See figure 1). The Marquillo Marquis F_1 material planted October headed between December 2nd and the 10 and set one per cent. of seed. Of the ot material sown October 1st, seed was obtain from the following: Acme x Khapli F_1, V nal x Marquis F_1, Khapli, Prolific Spri rye, Burt oats and O.A.C. 21 barley. Owi to the low seed setting of most of these th were harvested before maturity to make w for another planting on January 15th.

Figure I.
arquillo X Marquis F_1 plants on December 12,)25. The F_1 seed was sown on September 12, 1925.

The planting of January 15, 1926, was as extensive as that of the preceding fall. Seed was sown of all the hybrids and several of the varieties used in the fall plantings. Excellent growth was secured. (See figure 2.) In Table 1 the dates of heading, heights and other data are given.

The crosses differed considerably in various plant characteristics. The crosses of Marquis with White Spring (*T. dicoccum*) and Vernal (*T. dicoccum*) were later to head and much taller than the other hybrids; they also tillered well and gave an average seed-setting of 43.2 per cent. The one Khapli x Marquis plant that grew, headed after all of the other crosses were ripe but developed no seed. Khapli x Acme (*T. durum*) set 30.3 per cent. of seed. Crosses of Khapli with the other emmers proved to be nearly as fertile as the intra-vulgare crosses, Marquillo x Marquis and Double Cross x Marquis, which had the highest fertility of any of the crosses, averaging 90.7 per cent. Samples of the seed produced are shown in Figure 3.

Environmental Difficulties

Extreme deviations from the normal environment occurred twice. In December 1924, during sub-zero weather the temperature in the greenhouse fell to 20 degrees Fahrenheit and remained below 32 Fahrenheit for two hours. The barley hybrids did not appear to suffer from the low temperature but the anthers of wheat hybrids, which were in flower, shrivelled and turned whitish before maturity. In December 1925 a leak occurred in a gas pipe in the greenhouse and for about 12 hours the plants were exposed to the gas. The effects of the gas

TABLE I

esults obtained from the first generation of wheat hybrids grown in the greenhouse from January 15th to May 15th, 1926, through the aid of artificial light.

Hybrid	Days from seeding to heading	He ight of plant in inches	Number of tillers per plant	Number of F_2 seed set	Percentage of F_2 seed set
arquillo x Marquis	74	34	6.0	45,000	93.0
hapli x Marquis	122	22	1.0	0*	0.0
ernal x Marquis	78	45	4.0	185	46.6
hite Spring Emmer x Marquis†	80	43	4.7	148	39.8
ouble Cross x Marquis	73	38	1.5	115	88.5
elt x Marquis	72	40	1.0	64	78.0
hapli x White Spring†	71	35	7.0	224	73.7
hapli x Acme†	71	36	4.0	88	30.3

eciprocals averaged where the cross was made both ways.
)nly one plant grew from four seeds planted; that was weak and produced no seed.

Figure II.
Part of the January 15, 1926, planting of Marquillo X Marquis F_1 at maturity on May 8, 1926.

were quite noticeable but the amount of damage could not be ascertained.

Management of Artificial Light

The results of a special test made with several varieties of wheat, oats, barley and flax are shown in Table 2. The seed was planted on October 1, 1925, in eight-inch pots, four seeds to a pot. The plants that received the full intensity of artificial light (group 1) headed earlier, grew taller and had stronge[r] straw than those which had only one-fourt[h] of that intensity (group 2) or those whic[h] received no artificial light (group 3). Mar[quis] wheat in group 1 headed 69 days afte[r] seeding but required 75 and 83 days, res[pectively], in groups 2 and 3. The result[s] for Kubanka wheat were similar to those fo[r] Marquis. For Khapli wheat, Burt oats an[d] Prolific rye the differences were less striking

TABLE 2

Results obtained when representative varieties of cereals were grown in the greenhouse and supplied with different intensities of artificial light.

Notes.	Light intensity	Marquis wheat	Kubanka wheat	Khapli emmer	Banner oats	Burt oats	Hannchen barley	O.A.C. 21 barley	Prolific (Spring rye)
Days Seeding to Heading	(1)*	69	69	57	†	69	†	83	59
	(2)	75	71	61	†	72	†	83	62
	(3)	83	84	61	†	†	†	†	60
Height of plant in Inches.	(1)	26.5	34.5	23.0	21.0	31.0	19.0	24.0	33.0
	(2)	29.0	35.0	25.0	20.5	26.0	17.0	26.0	27.0
	(3)	24.0	34.0	22.5	17.0	24.5	14.0	20.5	30.0

* (1) Plants that received the full intensity of artificial light;
(2) Plants that had one-fourth of the intensity received by plants of (1).
(3) Plants that received no artificial light.
† Failed to head.

Figure III.

d of crosses grown in the greenhouse from uary 15 to May 8, 1926:—

Khapli X White Spring Emmer F_2.	4. Marquis X Vernal F_2.
Marquis X White Spring Emmer F_2.	5. Khapli.
Khapli X Vernal F_2.	6. Khapli X Acme F_2.
	7. Acme X Ruby F_1.
	8. Marquillo X Marquis F_2

Another light intensity experiment was made to determine the best time for commencing to supply the greenhouse crop with artificial light. Wheat plants that grew seven weeks before receiving artificial light were several days later in heading than those which had artificial light from the fifth week after planting. In general, the plants placed earlier under artificial light were shorter than the others and produced less seed.

Test of Winter Grains

Several plants of Kharkov winter wheat and Dakold winter rye were brought in from the field on October 15, 1925, from plots seeded on September 3rd. The plants which had ceased their fall growth in the field on account of unusually cold weather, resumed growth and headed on January 5, 1926, 124 days after seeding. The Dakold rye that remained in the field did not head until June 5, 1926. The rye brought into the greenhouse headed 151 days before that which wintered in the field. The Kharkov wheat that remained in the field headed on June 20th, or 166 days later than that taken into the greenhouse.

Three Successive Generations in One Year

As a particular instance of three successive generations of wheat being grown in one year, the hybrid Marquillo x Marquis was used. The seed of the parental varieties was sown on May 10, 1925, in the nursery. The cross was made in July and the mature F_1 seed harvested August 15th. On September 15th this seed was planted in the greenhouse in nine-inch pots and during the first week in January 1926, the progeny ripened seed. Ten of these F_2 seeds were planted on January 15th and mature seed was produced by May 8th.

Discussion

The feasibility of growing three successive crops of wheat in one year has been demonstrated. To be able to grow two successive generations during the winter is a valuable asset to the plant breeder. If he is unsuccessful in obtaining certain desired crosses in the field nursery, he can make the crosses and grow the F_1 progeny in the greenhouse during the fall and winter and raise the F_2 in the nursery the following summer. It should be particularly desirable in special genetic studies to grow both F_1 and F_2 material during the winter following the summer when the crosses are made.

The relatively low setting of seed in the fall plantings of October 15, 1924, and October 1, 1925, was apparently due to unfavourable environmental conditions that have been mentioned. There seems to be no reason for expecting less satisfactory results from the fall planting than from the January planting providing the environment is controlled properly.

The tests on the management of artificial light indicated that the use of a fairly high intensity of light is desirable if two crops are to be grown successfully during the winter. It also appeared that for wheat it is not necessary and probably not advisable to supply artificial light before the sixth or seventh week of the plant's growth.

Summary

1. Wheat and barley F_1 hybrids were grown in the greenhouse at Saskatoon during the winter of 1924-25 through the use of artificial light to supplement the natural daylight. The seed was planted on October 15, 1924 and the progeny ripened seed during the third and fourth weeks of January.

2. A second planting including hybrid material and several varieties of wheat, oats and barley was made February 4, 1925. Oats, barley and wheat crosses were made during the last week in March. The oat varieties and crosses produced very few seeds, but both wheat and barley varieties and hybrids were highly fertile, ripening seed during the period of April 24th to May 7th.

3. A large planting of varietal and hybrid material of wheat, oats, barley and rye was made on September 15th and October 1, 1925. The September 15th planting matured during the first week of January, 1926. Owing to the unfavourable environmental conditions the later planting set very little seed and was harvested before maturity.

4. On January 15, 1926, 200 eight- and nine-inch pots were planted with wheat hybrid seed. Some wheat and barley varieties were sown also. The crop matured during the first two weeks of May and yielded abundantly.

5. As a specific instance of three successive generations of wheat grown in one year the P_1, F_1, and F_2 generations of the cross Marquillo x Marquis were grown successfully from seeding to maturity during the period May 10, 1925 to May 8, 1926.

6. Certain species of wheat, oats, barle and rye of the October, 1925 planting we exposed to different intensities of artifici light. In general, the plants under artifici light headed earlier and grew taller tha those having only the natural daylight.

7. Later heading and increased height c plant and yield of seed were the general re sults of delaying the use of artificial ligh until the plants were well along in thei growth.

8. Dakold winter rye sown in the fiel September 4, 1925, and removed to the green house and placed under artificial light o October 15, 1925, headed January 5, 1926 The Dakold that wintered in the field heade June 2, 1926. Kharkov winter wheat similar ly treated headed on January 5th, 1925, in th greenhouse and on June 20, 1926, in the nur sery.

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The Origin and Development of the Dominion Dairy and Cold Storage Branch.

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During the winter of 1888-89, Mr. W. H. Lynch of Danville, Que., wrote a series of articles on the dairying industry which were syndicated in the daily and weekly press throughout Canada and which received rather wide circulation. He stressed the importance of organization and advocated the appointment of a Dominion official whose duty it would be to promote the dairying industry.

Mr. Lynch also attended the annual conventions of the provincial dairy associations, or communicated with these organizations, and suggested that they should appoint delegates to a general conference to be held in Ottawa. Accordingly a meeting of representatives of the industry in Ontario, Quebec, New Brunswick, Nova Scotia, Manitoba, and the North West Territories was convened at the House of Commons, Ottawa, on April 9, 1889.

Mr. H. S. Foster of Knowlton, Que., was elected provisional chairman and Mr. J. de L. Taché, then Secretary of the Quebec Dairymen's Association, now joint Librarian of the Library of Parliament, was chosen as provisional secretary.

After some discussion a committee on organization was named which consisted of the following delegates: Messrs. D. M. Macpherson, Lancaster, Ont., Hon. Louis Beaubien, Montreal, Que., W. H. Lynch, Danville, Que., J. C. Chapais, St. Denis, Que., E. Caswell, Ingersoll, Ont., The Hon. P. B. de la Bruére, Quebec, Que., first president of the Quebec Dairymen's Association, Ed. A. Barnard, Director of Agriculture, Quebec, Que., and Major Boulton of Manitoba, Commander of Boulton's Scouts during the second Riel Rebellion. When the committee reported, it recommended among other things that a new association be formed to be known as "The Dairymen's Association of the Dominion of Canada". When the election of officers took place, the following were chosen:

President—Mr. D. M. Macpherson, Lancaster, Ont.

Vice-Presidents—The Presidents of all the Provincial Dairymen's Associations.

Secretary—Mr. J. C. Chapais, St. Denis, Que.

Treasurer—Mr. H. S. Foster, Knowlton, Que.

DIRECTORS

Ontario: Mr. Wm. H. Eager, South Mountain; Mr. James Haggarty, West Huntingdon; Mr. E. Casswell, Ingersoll; Mr. Thos. Ballantyne, M.L.A., Stratford.

Quebec: Hon. Louis Beaubien, Montreal; Col. Ora N. Bernatchez, Montmagny; Mr. Ed. A. Barnard, Quebec.

New Brunswick: Mr. Julius N. Inches, Fredericton; Mr. Arthur C. Fairweather, Rothsay; Mr. George Fawcett, Sackville.

Nova Scotia: Mr. L. C. Archibald, Antigonish; Mr. Paul C. Black, Falmouth; Mr. John McKeen, Mabou, Cape Breton.

Prince Edward Island: Hon. Alexander Laird, Bedeque; Hon. D. Ferguson, New London; Mr. John Hamilton, New Perth.

Manitoba: Major Boulton, Shellmouth; Prof. S. M. Barre, Winnipeg.

North-West Territories: Mr. J. P. Dill, Wolseley.

As Parliament was in session, the delegates had the privilege, by invitation of the Chairman Mr. Peter White, M.P., of appearing before the Agricultural Committee and stating their views to that body.

A deputation from the newly formed association waited on the Prime Minister, the Right Honourable Sir John A. MacDonald, and other members of the cabinet including the Honourable Messrs. Carling, MacKenzie Bowell and Costigan. The deputation, in which the writer had the honour of being included, was introduced by Dr. T. S. Sproule, Member for East Grey, and Mr. Adam Brown, Member for Hamilton, and was accompanied by Mr. Sydney A. Fisher, the Member for Brome, who became Minister of Agriculture in 1896. The deputation made two specific requests, first, that a grant of $3,000 be made to the new Association and, second, that a Dairy Commissioner should be appointed.

Both requests were eventually granted, but as a preliminary step the Association was asked to name a committee to confer with the Minister of Agriculture (the Honourable John Carling) with respect to the selection of a Dairy Commissioner. If the writer's memory is correct, this committee conssited of Messrs. D. M. Macpherson, D. Derbyshire, Thos. Ballantyne M.L.A., H. S. Foster and Ed. A. Barnard who was then Director of Agriculture in th Province of Quebec, and when the committee came to the point of deciding as to whom it should propose for the position the situation became somewhat embarrassing from the fact that Mr. Barnard desired the position for himself. A compromise was effected by recommending Prof. Jas. W. Robertson as Commissioner and J. C. Chapais, a brother-in-law of Mr. Barnard's, as Assistant Commissioner. The appointments became effective on February 1, 1890.

It was said that the motive behind Mr. Lynch's activities was to have a position created which he could fill himself. His knowledge of dairying was rather superficial. Had it been equal to his facility as a writer or his volubility as a speaker, he might have been considered, but as it was he was quite overlooked and received rather scant consideration at the conference or by any of the committees. Nevertheless, he was the prime mover in the matter, and for that he deserved credit. Mr. Lynch's interest in dairying evaporated at once and he had no further connection with it. He was reported to have remarked at the time that the dairy industry might be removed to a warmer climate for all he cared, or words to that effect.

Mr. Chapais was never located at headquarters and had no executive or administrative duties, his services being largely confined to lecturing and giving instruction throughout the Province of Quebec and other French speaking districts, a kind of work for which he was well equipped. He continued to hold the position until April 1, 1924, when he asked for superannuation under the Calder Act. During the last years of Mr. Chapais' service, his time was fully occupied with the administration of the Agricultural Instruction Act in Quebec. He died on July 24, 1926.

When Prof. Robertson became Dairy Commissioner he was at the same time appointed Agriculturist to the Central Experimental Farms, and filled these two positions until he resigned the position of Agriculturist in De ember, 1895, and was gazetted as Agricultur and Dairy Commissioner. The title was sho ly afterwards changed to that of Commission of Agriculture and Dairying. As Agricultu ist Prof. Robertson was a member of the sta of the Experimental Farms, but as Dai Commissioner his position was entirely i dependent, and the members of his staff, they were appointed, came under his directi as Dairy Commissioner only. The Dai Branch never had any connection with the E perimental Farm although the office was loca ed on the Farm during the years that t Commissioner filled the dual positions.

During the first year of Prof. Robertson service, he travelled throughout the leng and breadth of Canada addressing meeting interviewing leading dairymen and making general survey of the whole situation. H fluency and persuasiveness as a speake coupled with his wide knowledge of the su ject, and his general optimism and enthusias made a great impression on the farmers Canada and created much interest in t dairy industry in a very short time.

In the spring of 1891, the organization the Branch really began and the writer ha the distinction of being the first person a pointed, on April 6th of that year. My fir duty was to learn to operate the Babcock Mi Tester and, in doing so, I used the first mac ine brought into Canada. A month later fu ther additions were made to the staff by th appointment of Messrs. John Robertson, T. Dillon, J. B. MacEwan and C. C. MacDonal Later in the year, the late C. F. Whitley an J. W. Hart were appointed.

As this article deals only with organiza tion, it is not proposed to follow in deta the activities or changes in personnel of th Dairy Branch during the 35 years of its e istence. There was at first no organization b Divisions as there is now. The term "Branch was not even adopted in the Department unt about the year 1900. Members of the dair staff were assigned to various duties as o casion arose. The establishment and opera tion of winter creameries in Ontario, summe creameries in the North West Territories an Nova Scotia, and cheese factories in Princ Edward Island; experimental work to deter mine the value of the Babcock Test as a basi for dividing the proceeds of cheese milk; th publication of bulletins; organizing and con ducting dairy stations and dairy schools, in

cluding the first years of the dairy school at St. Hyacinthe, Que., and the Eastern Dairy School at Kingston, Ont., were among the activities of the Branch during the first ten years of its existence.

In 1901, Prof. Robertson announced to the Committee on Agriculture of the House of Commons that the Dairy Branch then comprised the following Divisions, viz., "Dairying", "Live Stock", "Fruit", "Extension of Markets", "Poultry" and "Cold Storage". The "Seed Division" was recognized the following year. This was merely a departmental or ministerial arrangement, there being no statutory basis of organization at that period.

When Prof. Robertson, or as he had become better known, Dr. Robertson, left the Government service at the end of 1904, a reorganization took place. The Live Stock and Poultry Divisions became the Live Stock Branch under Mr. F. W. Hodson, who had been Chief of the Division for some years, with the title of Live Stock Commissioner. The Seed Division was made the Seed Branch under Mr. Geo. H. Clark. The Dairy, Extension of Markets, Fruit and Cold Storage Divisions remained as the Dairy Branch with the writer as Dairy Commissioner. A year later the designation was changed to that of the Dairy and Cold Storage Branch.

In 1914 the Fruit Division was made a separate Branch.

Again in 1923 there was a further reorganization of the Branch, as it exists today, and which is set forth in the following schedule.

ORGANIZATION AND PERSONNEL OF CHIEF POSITIONS, DAIRY AND COLD STORAGE BRANCH

Dairy and Cold Storage Commissioner—J. A. Ruddick, LL.D.

Divisions and Chiefs

Dairy Markets and Cold Storage—J. A. Singleton.

Dairy Produce—Joseph Burgess.

Dairy Research—E. G. Hood, B.S.A., Ph.D.

Dairy Manufactures—W. F. Jones, B.S.A.

Services

Administration of Dairy Laws—D. J. Cameron in charge.

Utilization of Milk—Helen G. Campbell in charge.

Principal Services now Assigned to the Dairy and Cold Storage Branch

(1) Grading of Dairy Produce; (2) Scientific Research in Dairying; (3) Study of World's Conditions in Dairying; (4) Correspondence and Advice on all Matters relating to Dairying and Cold Storage; (5) Inspection of Perishable Cargoes at Canadian and United Kingdom Ports; (6) Refrigerator Car Inspection; (7) Dairy Market Intelligence; (8) Promoting Uniformity in Dairy Manufactures; (9) Judging Butter and Cheese at Exhibitions; (10) Administration of the Cold Storage Act and Creamery Cold Storage Bonuses; (11) Enforcement of Dairy Laws, and (12) the Utilization of Milk and Its Products.

Many changes have taken place in the personnel of the Dairy Branch since 1891. Of those who were appointed to the staff that year, the writer is the only one now in the service or even engaged in similar work.

J. B. MacEwan accepted a position in New Zealand in 1893 and is now one of the successful business men of that country. C. C. MacDonald joined the Manitoba Department of Agriculture as Dairy Superintendent in 1894 and afterwards engaged in commercial work. T. J. Dillon gave up dairying for mining and other activities in 1897. John Robertson died in 1899. J. W. Hart, after filling positions in Brazil and the Southern States, was shot to death by a poacher on the estate of which he was manager, and C. F. Whitley died during the past year after a long illness. Six out of nine provincial Dairy Superintendents, or Dairy Commissioners, were at one time connected with the Branch. Geo. H. Barr, Director of Dairying for Ontario, who became so well known as Chief of the Dairy Division, was the last to sever his connection with the Branch. Dr. C. P. Marker, now Dairy Commissioner for Alberta, was a member of the staff for some years. W.W. Moore, Manager of the United Dairymen Cooperative at Montreal since 1920, was the first Chief of the Extension of Markets Division. J. A. Kinsella, who succeeded the writer as Dairy Commissioner in New Zealand in 1900, and afterwards filled similar positions in South Africa and Australia, was in charge, for the Branch, of the "Government" creameries in Saskatchewan for several years before he left Canada. He was succeeded in Saskatchewan by W. A. Wilson, who is now Agricultural Products Representative for the Department in the United Kingdom. Harvey Mitchell, Deputy Minister of Agriculture for New Brunswick, was for many years the representative of the Branch in the Maritime Provinces. J. W. Mitchell, who became Superintendent of

the Kingston Dairy School and Dairy Superintendent in Manitoba and, later, in New Brunswick, was also connected with the Branch for several years. H. W. Coleman, the first dairy produce grader at Montreal, is now owner and operator of a creamery at Carleton Place. There are many others who assisted in the work of the Branch at different times.

My own connection with the Dairy Branch has not been continuous since 1891. I resigned in September 1896 to become permanent superintendent of the Eastern Dairy School, Kingston, Ont., when it was taken over by the Ontario Department of Agriculture, after being conducted for two years by the Dairy Branch. In 1898 I went to New Zealand to be Dairy Commissioner in that country, returning to Canada in 1900 at the invitation of the Hon. Sydney A. Fisher, Minister of Agriculture, to rejoin the Dairy Branch.

The Dairymen's Association of the Dominion of Canada which played such an important part in the origin of the Branch, held one annual convention at Ottawa on February 17, 18 and 19, 1890, which was addressed by His Excellency, the Governor-General, Lord Stanley of Preston; the Honourable John Carling, Minister of Agric ture; Dr. Wm. Saunders, Director of Expe mental Farms; Prof. Robertson and othe After that the Association ceased to exist. all those who were identified with this mo ment, all but five or six have passed fro the scene.

It may be thought that I have given u due prominence to the conference of Ap 9, 1889, and the meeting of the short liv Dominion Dairymen's Association. The me ings in themselves were unimportant, b considering that out of the one recommenc tion there was developed no less than fo of the main Branches of the Dominion D partment of Agriculture, it must be admitt that some historic importance should be a tached to the occasion. The necessary init tive would have in all probability come fro some other source sooner or later, but "ho our to whom honour is due" is a very fa rule to follow.

One might go on at considerable length recount the achievements of the Dairy Bran during the 35 or 36 years of its existenc but lack of space and modesty forbids. any case it is possibly just as well to allo the public to judge for itself in a matt of this kind.

Organization of the Eastern Canada Society of Animal Production.

A meeting of men interested in animal husbandry work in Eastern Canada was held in the Chateau Laurier, Ottawa, on the evening of June 24th, 1926. At this meeting it was decided to proceed with the organization of a society for the animal husbandrymen in Eastern Canada and a board of provisional officers was appointed to proceed with the organization of such a society with instructions to hold the organization meeting in Toronto during the 1926 Royal Show.

On the evening of Nov. 17th a very successful dinner and organization meeting was held in the Grill Room of the Prince George Hotel, Toronto. President Wade Toole, Professor of Animal Husbandry, Ontario Agricultural College, presided over the dinner and meeting which was attended by 49 men interested in Animal Husbandry work.

Prof. J. P. Sackville of the University of Alberta and President of the Western Canada Society of Animal Production was the guest and speaker of the meeting. In his remarks Prof. Sackville indicated the opportunity for an organization of animal husbandmen and reviewed the ground which th were attempting to cover with a similar o ganization in Western Canada.

The meeting adopted the following Consti tution:

CONSTITUTION AND BY-LAWS OF THE EASTER CANADA SOCIETY OF ANIMAL PRODUCTION

1. *Name*—This Society shall be known a *The Eastern Canada Society of Animal Pro duction.*

2. *Object*—The object of the Society is t afford opportunity for the discussion of prob lems of common interest in animal industr and to encourage collective consideration o methods of investigation and instruction i Animal Husbandry.

3. *Membership*—Animal husbandry investi gators, instructors, administrators, extensio workers and university graduates engaged i other phases of the animal industry shall b eligible for membership. All application for membership shall be approved by th executive.

4. *Officers*—The officers of the Society shal consist of a President, two Vice-Presidents

one of whom shall be French speaking, and three Directors, one from the Province of Ontario, one from the Province of Quebec and one from the Maritime Provinces. These officers shall hold office for a period of one year, or until their successors shall be appointed. There shall be a Secretary-Treasurer who shall be appointed by the Executive and who will be an officer of the Society.

5. *Executive Committee*—The Executive Committee shall be composed of the Officers of the Society, three of whom shall constitute a quorum.

6. *Elections*—The election of officers shall be held at the Annual General Meeting of the Society. Nominations shall be made at the Annual General Meeting and the elections shall be conducted by ballot. Only members in good standing shall be eligible to vote.

7. *Meetings*—The Society shall decide at the Annual General Meeting the time and place for the next Annual General Meeting. Special General Meetings of the Society may be called by the Executive Committee. Notice of the Annual General or Special General Meetings shall be mailed to the members at least thirty days before the date of meeting. Meetings of the Executive Committee shall be called by the President of the Society and meetings of committees shall be called by the respective Chairman.

8. *Dues*—The dues of the Society for each year shall be fixed at the Annual General Meeting. The Society year shall end on May thirty-first.

9. *Committees*—The special work of the Society shall be conducted through Standing Committees. These Committees shall be determined and their membership appointed at the Annual General Meeting. Nominations for such Committees shall be made by a nominating committee of not less than ten members named by the Executive of the Society. Special Committees may be appointed by the Executive.

10. Amending the Constitution—The constitution of the Society may be amended at any Annual General Meeting of the Society by a vote of two-thirds of the total number cast. Notice of such proposed amendment shall be sent to members with notice of such meetings.

The meeting appointed the following standing Committees through which the special work of the Society shall be conducted:

Horse Production Committee — C. M. MacRae, Dominion Live Stock Branch, Ottawa, Chairman; R. W. Wade, Parliament Bldgs., Toronto; Dr. M. Cumming, Truro, N.S.; Dr. G. Langelier, Supt. of Experimental Farm, Cap Rouge, Que.; Dr. W. Fowler, Ontario Veterinary College, Guelph, Ont.; J. J. Gauvreau, Dept. of Agriculture, Quebec, P.Q.

Beef Cattle Production Committee — Prof. Wade Toole, Ontario Agricultural College, Guelph, Chairman; W. R. Reek, Ridgetown, Ont.; R. S. Hamer, Dominion Live Stock Branch, Ottawa; Prof. G. E. Day, Guelph, Ont.; J. A. McClary, Lennoxville, Que.; W. W. Baird, Nappan, N.S.

Dairy Cattle Production Committee—E. S. Archibald, Dominion Exeprimental Farm, Ottawa, Chairman; W. J. Bell, Kemptville; Prof. J. C. Steckley, Ont. Agricultural College, Guelph; Prof. G. Toupin, Institut Agricole d'Oka, Que.; Prof. J. M. Trueman, Agricultural College, Truro, N.S.; Dr. R. L. Conklin, Macdonald College, Que.

Sheep Production Commmittee—A. A. MacMillan, Dom. Live Stock Branch, Ottawa, Chairman; J. K. King, Moncton, N.B.; L. E. O'Neill, Dept. of Agriculture, Toronto, Ont.; N. Rodrigue, Dept. of Agriculture, Quebec; Geo. Muir, Experimental Farm, Ottawa; L. H. Hamilton, Macdonald College, Que.

Swine Production Committee—Geo. B. Rothwell, Experimental Farm, Ottawa, Chairman; L. C. McOuat, Dom. Live Stock Branch, Ottawa; Prof. A. Godbout, Ste. Anne de la Pocatière, Que.; A. W. Peterson, Charlottetown, P.E.I.; I. B. Martin, Ont. Dept. of Agriculture, Parliament Bldgs., Toronto; E. W. Crampton, Macdonald College, Que.

It was decided by the meeting that the Eastern Canada Society of Animal Production should apply for affiliation with the Canadian Society of Technical Agriculturists, also that the dues for the first year be One Dollar per member to cover incidental expenses.

The following officers were elected for the coming year:

Prof. Wade Toole, President; Dean H. Barton, Vice-President; J. A. Ste. Marie, Vice-President, S. E. Todd, Ontario Director, S. Boily, Quebec Director and Jas. Bremner, Maritime Director. Later at a meeting of the Executive, L. C. McOuat, Dominion Live Stock Branch, Ottawa, was appointed Secretary-Treasurer.

The time and place of the first annual meeting was left to the Executive with the recommendation that it be held in Ottawa during the week of the World's Poultry Congress.

L. C. McOUAT, *Secretary-Treasurer.*

Morphological Similarities in Alfalfa Strains.

G. P. McROSTIE, R. I. HAMILTON, N. O. LUNDBLAD

Forage Plant Division, Central Experimental Farm, Ottawa, Ont.

As the development of new alfalfa strains, by plant breeders, becomes more common, the necessity of a method of distinguishing such strains morphologically becomes imperative. The purpose of this article is to present some suggestions that may be found of value in describing new strains.

The separation of commercial mixtures of alfalfa into strains by means of inbreeding has been practiced for quite a few years at the Central Experimental Farm. The actual procedure of isolation has been described in detail in previous publications and consequently need not be commented on at this time except to intimate that it is essentially a process of prevention of all cross fertilization through succeeding generations. A few generations of such treatment give rise to strains that appear to be purified for certain well defined morphological characteristics.

During the summer of nineteen twenty-six, the writers made a great many careful observations, notes and measurements in an endeavour to discover morphological characters, within the strains at our disposal, which were constant enough to be used in the description of such strains.

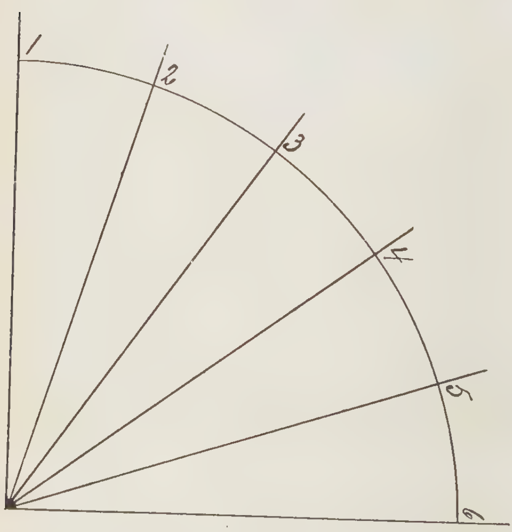


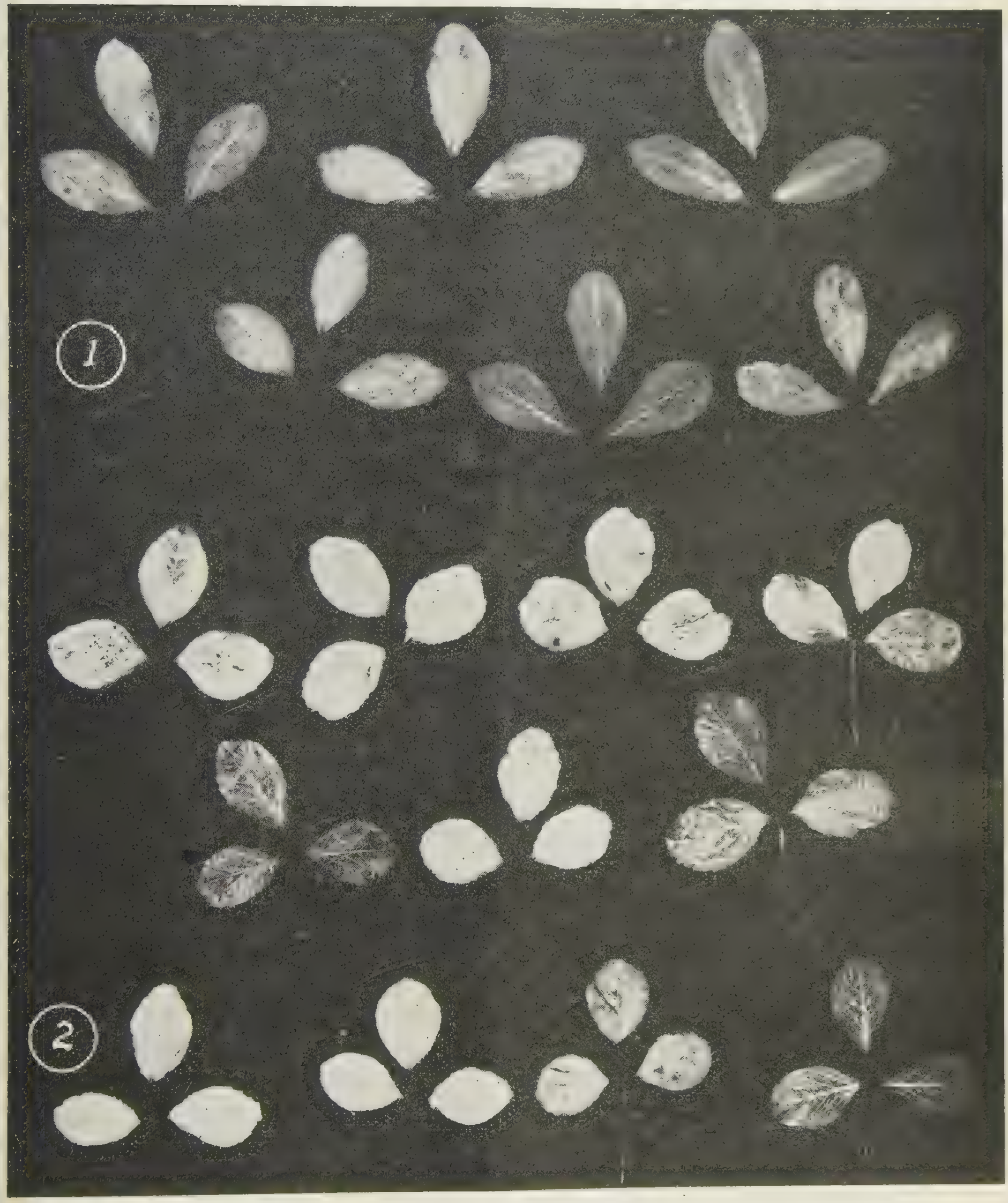
Chart No. 1.

In this connection the general attitude of the plant was found to be quite constant within any strain examined. This characteristic was determined by reference to Swedish chart No. 1. Only the main stems were considered in attitude determinations.

The general colour of the main stems as well as the leaves also proved to be a constant factor, and was determined by direct comparison with the colour plates in Ridgeway's "Classification and Nomenclature of Colours". The same publication was used also for all colour determinations of other parts of the alfalfa plant.

A second character that we found very useful in differentiating between strains was the leaf. Any person who has observed an alfalfa plant at all closely will realize that apparently a considerable variation exists in the size and shape of the leaves on any individual plant. While such a condition is evident we must at the same time realize that the leaves we see represent varying stages of maturity of the organ concerned. In common with many other plant parts the true expression of form appears to be found only in the mature structure. The primary leaves on the main stems of the first growth in any season would therefore, seem to be the ones most likely to have attained full maturity and hence full expression of shape and size. That a marked degree of uniformity exists in such leaves not only on any individual plant but also within the different individuals of inbred strains, is borne out by a careful examination of Plates Nos. 1-2-3-4-5-6. Each individual cut represents leaves taken at random from the main stems of different plants constituting the strain in question.

The stipules of the various lots of leaves are shown in Plate No. 7. These also show a morphological similarity characteristic of the strain.


1
2

It was found to be difficult to get a photograph of leaves and stipules that would indicate shape at all definitely. To overcome this difficulty the leaves were first dried slightly and then placed directly on a regular printing paper. This latter operation of course had to be carried out in a dark room. A regulation printing frame was utilized and exposures were made from a few seconds to as much as three minutes duration, depending on the intensity of the light and the density of the material being worked with.

A further character, showing marked similarity within strains is the colour of blossom. It is true that variegated colours occur within an individual flower but where such is the case practically all flowers on the plant will be similarly effected. The extent and nature of the variegation seems to correspond somewhat to the condition found in variegated pericarps of corn, in which the condition of being variegated may be constant but the colour pattern variable.

Finally the density of the head as indicated by the number of flowers per unit length of rachis or peduncle was found to be uniform and appreciably different in many strains. This character was recorded in terms of the length of rachis in millimeters divided by the total number of flowers found on the head.

A descriptive table is included indicating the method of utilization of the morphological characters described in differentiating strains. The separation and description of the strains listed is quite easily accomplished when the strains have been inbred to a reasonable degree of purity. The separation of genetic mixtures is much more difficult but it should be even possible to obtain such mixtures that showed similarity in at least one or two of the morphological characters mentioned.

TABLE NO. 1.—DESCRIPTION OF SIX INBRED STRAINS OF ALFALFA GROWN AT THE CENTRAL EXPERIMENTAL FARM.

	Stem							Leaf		Stipule		Head	
	Attitude						Colour	Shape	Colour	Margin	Shape	Colour	density
	1	2	3	4	5	6							
Lot No. 1			X				Lettuce green	No. 1*	Cedar green	Serrate	No. 1*	Raisin purple	1.428
Lot No. 3		X					Light cress green with a shade of Indian red at base.	No. 2	Yew green	Slightly serrate	No. 2	Manganese violet	1.088
Lot No. 24			X				Light elm green with a shade of Indian red at base.	No. 3	Elm green	Serrate	No. 3	Hortense violet	1.331
Lot No. 34			X				Light cress green with a shade of Indian red at base.	No. 4	Cress green	Entire	No. 4	Hortense violet	1.412
Lot No. 35			X				Cress green	No. 5	Yew green	Serrate	No. 5	Pansy violet	0.694
Lot No. 41		X					Light creess green	No. 6	Light elm green	Serrate	No. 6	Raisin purple	1.188

* Numbers refer to photographs of the leaves and stipules of the various lots.


3
4


5
6

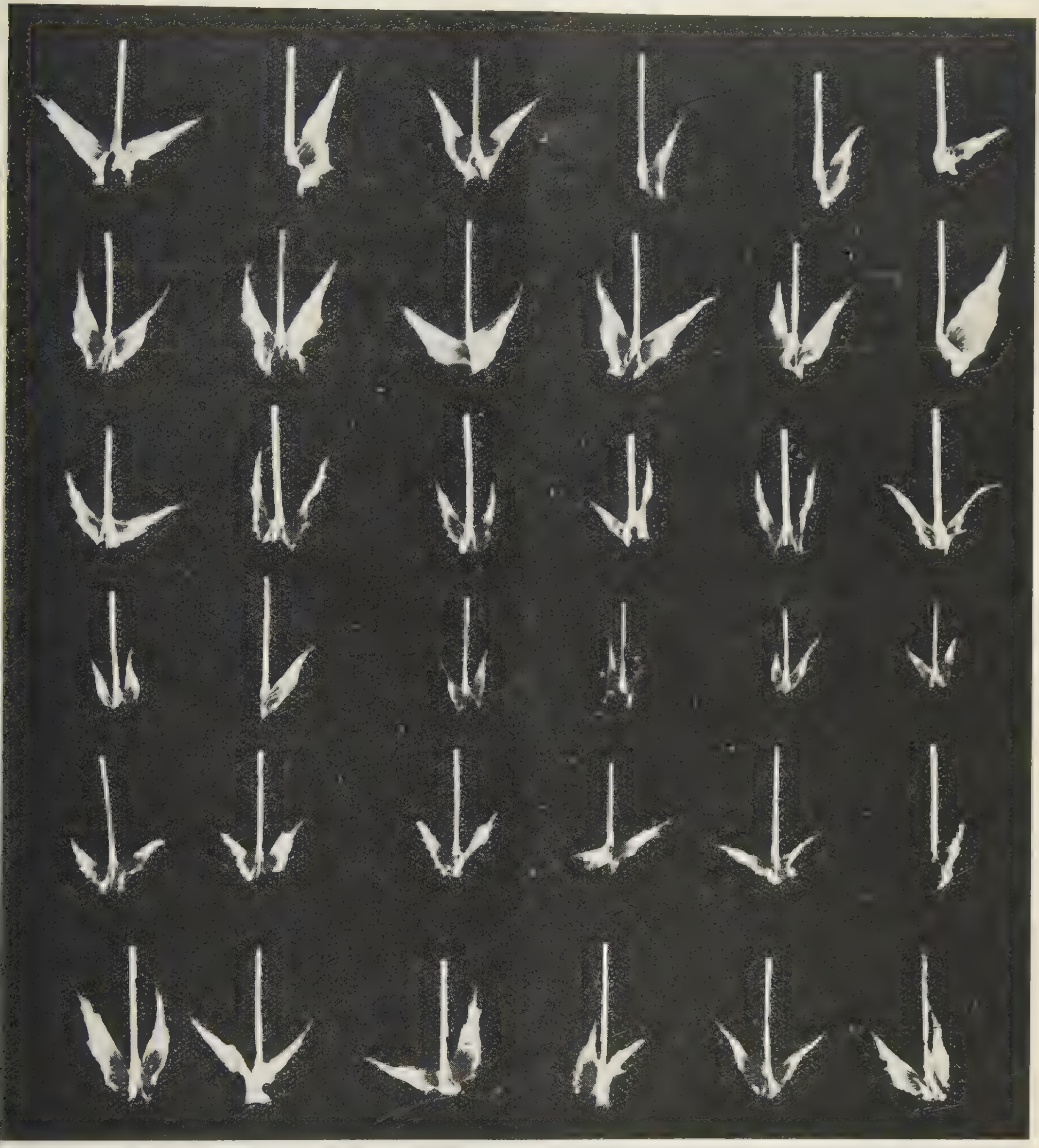


Plate No. 7

Can We Predict the Nature of the Potato Crop with Any Degree of Accuracy.

JOHN WALKER

Assistant to Superintendent, Dominion Experimental Farm, Indian Head, Sask.

Although the limits of improvement in the potato by the tuber unit and hill selection methods are definite and somewhat narrow, yet the benefits derived from either method warrant their continuance in general practice. The attainment of purity, trueness to type, uniformity in shape, disease resistance, increased yield and removal of weak, unproductive and diseased tubers within a variety can be hastened and realized by either of the methods of seed selection mentioned.

Investigators prominently identified with potato improvement research, however, entertain little hope of succeeding to create or isolate something new from asexual selection. They, likewise, doubt if any method of seed selection will prevent the "running-out" of potatoes under certain conditions. On the other hand, since the theory of the permanency of the clone has been fairly definitely established (classical exceptions designated as bud sports need not be specified here) stability in character manifestation in subsequent progenies may be relied upon in the potato.

Many influences, however, individually or collectively, profoundly modify the final expression of characters. Where optimum growing conditions exist, the yield seems to be, within limits, proportional to the size of the seed pieces used; in other words, where the growing season is long seed pieces with one strong eye will produce a satisfactory crop, and where the growing season is short growers are recommended to use seed pieces with more than one, preferably two, eyes.

On clay soils, tubers are usually thicker, broader and shorter than those of the same variety produced on sandy land. This influence, however, has not been found to be carried over in any detectable amount to the progeny. The same applies to the progenies of tuber units which, due to environmental conditions, may be distinguished as low or high-yielding. Neither has there been found any degree of correlation between the form of tubers and yield.

The formation of knobs or second growths is largely influenced by conditions of environment during development. On an early maturing strain of the Early Ohio variety at the experimental farm, Indian Head, in 1926, no knobs were present, while on some of the later varieties they were quite numerous. These knobs represent extended or renewed starch assimilation and accumulation without the formation of new stolons. Varieties seem to differ with respect to capacity for continued enlargement of original tubers, and, with warm weather, accompanied by rains during the month of August, second growths will frequently result, especially if growth in June is slow.

Fissures or cracks in the tubers are also physiological in nature, and subsequent progenies do not inherit the tendency. Likewise, the depth of eyes and prominence of eyebrows may be distinctly different in tubers of one potato variety grown in dissimilar surroundings, but these characters will be expressed in the progenies according to the environmental conditions under which the tubers develop.

Growers frequently overlook the importance of the position of the eye or eyes on the seed piece or set. It has been shown that the vigor of the sprouts from the different quarters of single tubers is directly correlated with the position on the seed piece. Inspection of the hills at digging time in 1926 revealed the fact that plants attached near the tip or edge of seed pieces were less vigorous and smaller than those whose buds arose from more centrally located eyes. Invariably, little of the food stored in the seed pieces of the former class had been used up by the plants, while in the latter its utilization was usually complete. This signifies that the centrally placed sprouts can more readily avail themselves of the reserve food and, therefore, begin growth more vigorously. It must, however, be remembered that second sprouts from eyes are less vigorous than original ones; hence, the desirability of storing seed tubers

in conditions under which they will remain dormant until planting time.

The diseases to which most potato varieties are susceptible also influence results very markedly. For those whose control require measures other than recognized methods of seed treatment the adoption of the tuber unit method of planting in the multiplication plot offers a means whereby diseased units can be speedily and effectively discarded. Where this method of planting is followed, the isolation and selection of early or late units within a variety is also readily accomplished.

It will be seen from the observations and results presented here that uniformity in size of plants, number and weight of tubers per hill, shape of tubers and in other characters can be expected only if conditions of environment during growth are similar and relative uniformity exists among the seed pieces. This means careful selection of disease-free seed stock at harvest time, storage in conditions conducive to good keeping (cool and fairly dry) with no subsequent sprouting, efficient seed treatment before planting, the planting of uniformly prepared sets in uniformly prepared soil at equal depths and similar cultivation given throughout the season.

Results are also influenced by moisture, heat, sunshine and frost. These contributory influences are beyond the control of the growers, however, just as a discussion of them is beyond the scope of this article.

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Book Reviews

ENZYMES, by Waksman, A.S., and Davison, W.C. (Williams & Wilkins Company, Baltimore, U.S.A. $5.50).

The growing importance of the concept of enzymes in the re-actions of plants, animals and micro-organisms has been expressed by an increasing array of publications dealing with various phases of this subject. The ordinary reader cannot help but be confused by the apparently contradictory results that have been published. The difficulty of securing anything like a comprehensive understanding of enzymes was thus very considerable. The present publication by Waksman and Davidson deals with the whole important subject of enzymes from a strictly modern point of view, fortified by the latest and fullest knowledge of the subject. At the same time an interesting review of the earlier theories relating to enzymes is included. The book contains twenty-five chapters which are arranged in four major sections:—the properties of enzymes; their distribution; their preparation and study; and finally the practical application of enzymatic activities. Over two thousand references were consulted in the preparation of this book and the information gleaned from this confusing array of data has been arranged intelligently in a form easily understood by the ordinary reader. The keynote of the whole publication appears to be conciseness and simplicity of presentation, yet little is sacrificed that would ensure a proper understanding of the various phases of enzymatic reactions referred to.

Not the least valuable is a bibliography of thirteen hundred and twenty-three publications which is included at the end of the book while hundreds of references concerning the various subjects dealt with may be found scattered throughout the four major sections.

The book is not only the most recent contribution on the subject of enzymes but is considerably the most comprehensive and detailed of any as yet undertaken. To the average reader it will prove interesting and enlightening and to the investigator in its own field it should be almost invaluable.

G. P. McR.

La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

Les plantes fourragères pour prairies et pâturages artificiels: leur histoire et les sources de leurs semences.

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La culture fourragère, le fondament de l'industrie animale qui a pris un si bel essor au Canada dans les deux décades passées, est d'origine beaucoup plus récente que la culture des céréales ou d'autres plantes qui peuvent servir directement comme nourriture à l'homme. Elle n'était guère connue avant le commencement du dixhuitième siècle, parce que les herbages naturels en été et la paille en hiver étaient suffisants pour nourrir le bétail qu'on tenait principalement pour la production du fumier. Un vieux dicton flamand dit: "Sans fourrage, pas de bétail; sans bétail pas de fumier; sans fumier pas de récoltes." Il est nécessaire d'ajouter que le mot 'récolte', dans ce diction, a sans doute rapport seulement aux récoltes de céréales, la seule culture qui rapportait au paysan de ce temps une rémunération monétaire. Nous trouvons donc une subordination complète de l'industrie animale—et avec elle, naturellement, de la culture fourragère—à la culture des céréales. L'importance respective de ces trois branches de l'exploitation agricole aujourd'hui et il y a cent ans est peut-être la meilleure illustration de l'évolution de l'agriculture pendant le siècle passé. En général on peut dire que le développement de la culture fourragère est un des meilleurs indices de l'intensité de l'agriculture dans une région donnée. Pour cette raison il s'attache un intérêt tout spécial à l'étude de son histoire, surtout de l'histoire des prairies et pâturages artificiels. Pour la province de Québec ceci a d'autant plus d'importance que l'étendue totale de la surface consacrée aux plantes fourragères, en 1925, était de 4,224,000 acres comparée avec 2,061,000 acres de céréales. Il n'y a pas de doute qu'un aménagement amélioré des prairies et des pâturages de la province serait un des moyens les plus efficaces pour augmenter le rendement de ses fermes.

Pour avoir du succès dans l'établissement et l'entretien des prairies artificielles, qui sont essentiellement des associations biologiques de plantes semées dans des combinaisons et des proportions assurant les plus hauts rendements possibles sous les conditions climatériques et pédologiques données, il faut connaître intimement les caractéristiques de chaque plante composante. Il en est de même avec l'histoire des prairies et pâturages artificiels: elle se résout dans l'histoire individuelle des plantes fourragères.

A l'exception de quelques plantes originaires du sud des Etats Unis, l'Amérique du Nord a fourni seulement une plante indigène à la liste des graminées et légumineuses cultivées comme fourrage, le ray-grass de l'ouest. Toutes les autres sont originaires de l'Europe ou de l'Asie, et seulement un nombre très limité parmi elles a trouvé jusqu'à présent une place permanente dans les mélanges semés dans notre région. Une raison pour ceci est le fait que les conditions climatériques de l'est de notre continent ne se rapprochent de celles d'aucune région de l'ancien monde, de sorte que la culture de beaucoup de plantes qui

donnent de bons rendements en Europe n'est pas profitable ici. Admettons que très peu a été fait jusqu'à présent dans la sélection de variétés mieux adaptées, un procédé qui promet pourtant beaucoup, vu la polymorphie extrême montrée par la plupart des plantes fourragères. D'autre part, il ne faut pas oublier que relativement peu d'expériences ont été faites avec un nombre d'espèces, surtout dans des mélanges complexes comme ils s'employent fréquemment dans les pays classiques de la cultures fourragère, pour des assolements de longue durée. C'est ici une phase de la grande culture qui mérite une étude approfondie. On en peut dire autant de la production de semences qui n'a pas encore reçu l'attention qu'elle mérite, tant en ce qui concerne la production pour nos besoins domestiques que la production pour l'exportation.

Le trèfle rouge. *(Trifolium pratense* L.)

L'introduction générale du trèfle rouge a révolutionné l'agriculture autant ou davantage que tous les autres facteurs nouveaux, au cours des deux derniers siècles, à l'exception peut-être de l'introduction des engrais chimiques. Sa culture n'était pas connue des Romains, malgré qu'on ait des raisons de croire qu'il était cultivé en Médée bien avant le temps de l'empire romain. Les premiers qui en font mention comme aliment du bétail sont Ste. Hildegarde,* dans sa "Physica", en 1150, et Albert le Grand, qui en parle au treizième siècle. Farrelli le recommande au sénat de Venise, en 1566. Le botaniste néerlandais Dodonaeus donne des conseils pratiques pour sa culture dans la même année, et Clusius parle de son introduction en France en 1583. En Angleterre, le chancelier Richard Weston, comte de Portland, a eu beaucoup de mérite pour son introduction. Malgré ceci, la culture du trèfle rouge ne devint générale en Europe qu'avant la fin du dixhuitième siècle. A en croire les historiens, les autorités ont en maintes occasions du forcer les paysans à l'adopter avant qu'ils n'en reconnaissent la grande valeur.

On peut présumer que les premiers colonisateurs apportèrent le trèfle rouge en Amérique, où il n'est pas indigène, mais nous n'en avons pas de preuve avant 1747 quand Jared Eliot en parle dans ses ouvrages. Aujourd'hui il est répandu dans toute la zone tempérée du monde.

La graine du trèfle rouge est produite presque dans tous les pays où il se cultive, surtout depuis qu'il a été démontré péremtoirement que les semences produites localement donnent presque toujours des résultats supérieurs à la graine importée, surtout dans les pays avec un climat rigoureux. Malgré ce fait bien connu, quelques pays doivent importer presque la totalité de leur besoins annuels; malheureusement le Canada n'est pas encore dans une position de suffire à ses besoins domestiques, alors que nous devrions être capables d'exporter un surplus considérable qui trouverait très facilement un débouché à de bons prix. Les pays les plus importants qui exportent de la graine de trèfle rouge sont la France, l'Italie, le Chili, et les Etats-Unis. Avant la guerre, la Russie était une source importante. Dans des années favorables l'Angleterre, la Pologne, la Hongrie, la Bohême, la Hollande et l'Allemagne exportent un peu de graine. Tant que nous ne pourrons pas produire assez de graine pour nos besoins, les Etats-Unis seront notre meilleure source vu que la graine se produit principalement dans les Etats du nord, ayant un climat semblable au nôtre. (Wisconsin, Michigan, Illinois, Iowa, Missouri.) Il est à espérer que les efforts faits par les autorités pour stimuler la production de la graine de trèfle dans la province de Québec seront couronnés de succès. A présent la production au Canada est localisée comme suit: aux alentours de Montréal, dans l'ouest de la province d'Ontario, et dans le district de Kenora. Depuis peu, la Colombie britannique promet de produire une belle quantité.

La luzerne. *(Medicago sativa* L)

La luzerne est la plus ancienne des plantes fourragères cultivées. Dans l'ancienne Grèce on l'appelait "Medica" parce qu'elle était importée de la Médée, lors de la guerre contre les Perses, en 470 avant Notre Seigneur. On croit qu'elle était cultivée en Perse beaucoup avant ce temps. En Italie elle était connue au moins deux siècles avant notre ère, et au temps de Varo, Virgile et Columelle, sa culture était populaire. A en croire quelques écrivains elle se perdit complètement dans ce pays pendant les temps agités de la migration des peuples, parce que Crescentio

*Pour beaucoup de références historiques qui ne sont pas accessibles dans l'original nous avons consulté l'excellent ouvrage de Stebler & Volkart, "Die besten Futterpflanzen", Bern, 1913.

ne la mentionne pas dans son livre très détaillé pour le reste. Il semble établi cependant, qu'elle envahit l'Espagne et l'Italie, et de là fût apportée, autour de 1550, en France. Depuis ce temps la luzerne a conquis pratiquement le monde civilisé entier, apportant partout une prospérité croissante et des bienfaits innombrables.

Son histoire en Amérique est peu connue avant 1854. En tout cas elle n'était pas cultivée sur une grande échelle avant ce temps, mais elle prit un grand essor lorsqu'elle fût importée du Chili au cours de cette année. Aujourd'hui elle est de première importance, et il y a beaucoup de districts sur ce continent où une agriculture permanente serait impossible sans cette plante.

Nous connaissons trois formes principales de la luzerne, à savoir la luzerne commune *(Medicago sativa* L.), la luzerne jaune, *(Medicago* L.) et la luzerne rustique *(Medicago media Pers.)*. Cette dernière est aussi regardée par quelques botanistes comme une forme hybride entre les deux premières, et il y en a d'autres qui maintiennent que toutes les trois sont seulement des variétés d'une espèce botanique. La luzerne rustique a beaucoup attiré l'attention, durant les dernières années, en Amérique, surtout sous le nom de Grimm et, plus récemment, de "Ontario Variegated". Ces deux formes ne se laissent pas distinguer botaniquement. On connait peu de chose quant à l'origine de la luzerne rustique. Elle était cultivée presque simultanément dans plusieurs districts de l'Allemagne, autour de 1820. En 1857 un peu de graine fut apportée par un immigrant de Wertheim, Allemagne, dans l'état de Minnesota et, par sélection naturelle, la variété de Minnesota et la variété dite Grimm s'est développée de ce début. L'histoire de la "Ontario Variagated" est également plutôt obscure, mais il n'y a pas doute qu'elle provint originalement à peu près de la même source que la Grimm.

Suivant les sources de la graine, on distingue aussi quelques variétés géographiques, telles que les variétés dites Turkestane, Argentine et Péruvienne; ces pays exportant des quantités considérables de graine. La luzerne du Turkestan se distingue en même temps par des caractéristiques botaniques assez fixes des autres variétés de luzerne provenant de régions différentes. Des pays européens, la France est la région la plus importante de production, qui est localisée dans la Provence.

L'histoire de la production de la graine d[e] luzerne au Canada se lit presque comme u[n] roman. Jusqu'à 1920, nous étions forcé[s] d'importer presque la totalité de nos besoins tandis que l'année passée nos exportations dé[-] passaient 60,000 minots. Ce changement es[t] dû à la réputation excellente dont jouit l[a] luzerne rustique d'Ontario, qui a créé une bonne demande non seulement sur les marchés domestiques, mais surtout aussi sur les marchés des Etats-Unis. D'après les chiffres officiels du laboratoire de semences à Washington, ce pays importait 7,750,000 lbs. de graine de luzerne de l'Argentine en 1923 et seulement 3,600 lbs. du Canada, tandis qu'en 1926 les chiffres étaient de 221,700 lbs. et 4,218,800 lbs. respectivement. Voilà un beau succès, qui devrait nous inspirer à en faire de même avec la production de la graine du trèfle rouge.

De la graine enrégistrée de luzerne Grimm se produit aussi en Alberta, dans le district d'irrigation de Brooks, par une société coopérative. Des sociétés semblables travaillent à un même but dans les Etats arides ou sémi-arides de l'ouest, tel que le Montana, et beaucoup de luzerne commune est produite dans l'Utah et le Kansas.

Trèfle d'Alsike. *(Trifolium hybridum* L.)

Le trèfle d'Alsike,-nommé ainsi d'après un petit village suédois—est une des additions les plus récentes à la liste des plantes cultivées. Recommendé déjà par Linné, il ne s'est pas popularisé avant le milieu du dixneuvième siècle. Les classiques de la culture fourragère—Sinclair, Arthur Young, Schwertz—ne le connaissaient pas. Il fut sans doute cultivé d'abord en Suède, d'où il fut importé en Angleterre par George Stephens en 1834. Sur le continent, nous trouvons sa culture mentionnée la première fois par Metzger en 1841, en assumant que les données de Whistling regardant sa culture en France, autour de 1800, sont erronées et se rapportent à une forme alliée, Trifolium elegans Savi, ce qui est fort probable.

Dans les Etats-Unis il était distribué par le bureau des Brevets en 1854. Il n'est pas probable que sa culture au Canada soit antérieure à cette année.

Le Canada contrôle la production mondiale de la graine du trèfle d'Alsike, industrie bien établie dans quelques comtés de la province d'Ontario, surtout le comté de Victoria. Aux EtatsUnis il s'en produit un peu pour les be-

oins locaux. Les pays scandinaves, l'Allemagne et la Tchékoslovaquie sont les producteurs européens les plus importants.

Le trèfle blanc. *(Trifolium repens* L.)

Le trèfle blanc n'a guère d'égal comme plante pour pâturage. Il n'est donc pas surprenant que sa valeur agricole ait été reconnue d'abord en Hollande et en Flandre, pays qui appellent par leurs noms seuls des images paisibles de vaches broutant l'herbe riche. Comme le trèfle blanc est propre pratiquement à toute l'Europe et comme il se maintient très facilement, la production de sa graine resta limitée pendant plus d'un siècle. Il s'en vendait un peu de la Hollande à l'Angleterre, et plus tard le trèfle blanc s'introduisit, de la même source, en l'Allemagne. En Amérique il suivit partout les colons à en croire un adage de quelques tribus indiennes qui, d'après Strickland (1794), l'appelaient "l'herbe du pied de l'homme blanc", croyant qu'il poussait partout où l'homme blanc mettait ses pieds. Malgré cela son usage comme plante agricole est plutôt limité en Amérique. Il s'emploie bien davantage pour la production de gazon, en mélange avec des graminées.

Les sources commerciales de la graine sont la Nouvelle Zélande, la Hollande, l'Angleterre (la variété sauvage), l'Allemagne, la Pologne et les pays voisins, l'Italie (la variété latine), et les Etats-Unis.

Le trèfle d'odeur. *(Melilotus alba* L.)

Parmi les autres légumineuses fourragères le trèfle d'odeur est la plus importante pour le Canada. Cultivé déjà durant l'antiquité dans la région à laquelle nous devons aussi le trèfle rouge et la luzerne, sa culture ne s'est jamais popularisée en Europe où il est presque inconnu, même aujourd'hui. Il n'est pas originaire de l'Amérique, mais son introduction n'est pas du tout récente. Clayton l'a trouvé en 1739 en Virginie. En 1865 Tutweiler distribuait de la graine, importée du Chili, dans quelques Etats du sud, où il a joué un rôle important depuis plus de quarante ans. Pendant les années récentes il s'est bien établi aussi plus au nord dans certaines régions où l'on éprouve de la difficulté à cultiver le trèfle rouge ou la luzerne. La production de la graine est très simple et les récoltes sont d'habitude abondantes de sorte qu'elle se pratique presque partout où le trèfle d'odeur se cultive.

Le mil. *(Phleum pratense* L.)

Cette graminée n'a pas de rival du point de vue de l'importance pour la production du foin dans l'Amérique du nord. Malgré qu'il soit indigène en Europe, le mil a été cultivé d'abord aux EtatsUnis. Jared Elliot nous rapporte qu'un nommé Herd le trouva dans le New Hampshire au dix-huitième siècle et le cultiva. De là le nom "Herd grass" sous lequel il est connu dans la littérature agricole de cette période. En 1760 un échantillon de graine fut importé de la Virginie en Angleterre par Peter Wynch, président de la société agricole de Londres. Sur ses recommandations et à la suite de celles de Le dres, il se cultivateur de la banlieue de Londres, il se répandit rapidement dans toute l'Europe du nord, où son importance est même à présent croissante grace à de bonnes sélections faites dans les stations-expérimentales.

Les Etats-Unis produisent un surplus très considérable de graine pour l'exportation, dans les états de Iowa, Missouri, Minnesota, Illinois et Ohio. Il n'y a pas très longtemps la province de Québec pouvait bien suffire à sa demande locale, et même en exporter, mais la production de la graine a été enrayée surtout par la marguerite blanche, dont la graine est très difficile à enlever. Dans les années favorables nos Provinces Maritimes produisent la plupart de leur graine localement; il en est de même dans quelques districts de l'Ontario. Jusqu'à 600 000 lbs., par année, sont produites dans l'ouest, notamment dans les alentours de Pincher Creek, Alberta.

La dactyle pelotonnée.

(Dactylis glomerate L.)

Cette plante serait indigène en Amérique, d'après Basey, mais Asa Gray et avec lui beaucoup de botanistes américains maintiennent qu'elle fut importée de l'Europe. En tout cas, comme le mil, elle fut cultivée d'abord en Amérique, d'où elle fut rapatriée en Europe par la société des Arts, de Londres, en 1760. E.v. Fellenberg s'est donné beaucoup de peine pour son introduction en Suisse et sur le continent en général, autour de 1800. Aujourd'hui la dactyle pelotonnée est employée bien plus généralement en Europe qu'ici, et elle se cultive aussi avec succès dans la Nouvelle Zélande. En Europe un nombre de variétés excellentes ont été développées, surtout au Danemark. La graine

provient, outre de ce pays, surtout de la Dauphiné, des Etats de Kentucky, Indiana, Ohio et Virginie, de la Nouvelle Zélande qui en exportent depuis plus de quarante ans des quantités très considérables, et de la Hollande. Des essais dans la province d'Ontario ont démontré que la production de la graine de cette graminée serait une industrie profitable dans ce pays, dans des conditions favorables.

Le pâturin des près. *(Poa pratensis* L.*)*

De 1750 à 1850 on trouve de fréquentes controverses, dans la littérature agricole, sur la valeur des pâturins, mais malheureusement le pâturin des près et le pâturin commun *(Poa trivialis* L.*)* étaient très souvent confondus par les écrivains, de sorte qu'il est très difficile de retracer l'histoire exacte soit de l'un ou de l'autre. Le pâturin des prés fut cultivé d'abord en Angleterre sous le nom de "bird grass", mais il a acquis beaucoup plus d'importance dans les états de Kentucky, Missouri et la Virginie, où il forme l'herbe prépondérante des fameux pacages. En ordre d'importance, le pâturin des prés prend sa place, en Amérique, immédiatement après le mil. Piper dit que 90% des prairies où il domine se sont formées spontanément.

La graine du commerce provient presque exclusivement des états de Missouri, Kentucky et Iowa. Il s'en produit un peu aussi en Allemagne, d'où on peut obtenir trois ou quatre sélections qui ont beaucoup de valeur dans certaines conditions.

Le traitement de la graine, après la récolte, est très difficile, parce qu'elle s'échauffe facilement et perd sa faculté germinative. Ceci est dû en partie à de longs poils qui sont très nombreux à la base de la graine *(lana conjunctiva)* et qui forment des agglomérations compactes de graines. Avant d'être mise dans le commerce, la graine est traitée dans des machines spéciales pour enlever cette laine.

Nous avons certains districts dans l'ouest, oû la production de cette semence pourrait être profitable, notamment dans la région de Winnipeg où le pâturin des prés est l'herbe naturelle Dominante.

Le pâturin du Canada. *(Poa Compressa* L.*)*

Originaire du vieux continent, malgré son nom, ce pâturin a été trouvé aux environs de Québec par Michaux, déjà en 1792, et en 1823 Richardson le trouvait même sur l[e] cours supérieur de la rivière Saskatchewa[n]. Aujourd'hui il est l'object d'une culture co[n]sidérable au sud et au centre de la provinc[e] d'Ontario, qui est la seule source pour l[a] graine de ce pâturin, dont la majeure part[ie] est exportée aux Etats-Unis. Beaucoup d[e] graine provient de récoltes spontanées qu[i] viennent après le blé ou dans les pâturages.

Le Ray—grass anglais.

(Lolium perenne L.*)*

Cultivé en Angleterre depuis plus de 3C[0] ans, cette herbe est la plus ancienne de[s] graminées fourragères. C'est un nommé Eu[s]tache, dans le comté d'Oxford, à qui revien[t] l'honneur d'avoir reconnu le premier la va[l]eur du "gramen loliaceum", ancien nom d[e] ce ray—grass. Il n'existe guère une plant[e] dont les mérites et démérites on été sujet[s] à plus de controverses que le ray—gras[s] anglais. Pendant des décades sa culture fu[t] abandonnée, seulement pour être reprise pa[r] quelqu'un avec plus d'enthousiasme, et au[]jourd'hui l'on peut dire que ce ray—gras[s] mérite bien une place sous des conditions fav[]orables à son développement. Sa graine nou[s] vient de l'Ecosse, de l'Irlande, la Nouvell[e] Zélande et l'Australie.

Le Ray—grass italien.

(Lolium multiflorum Lam.)

Le nom *Lolium italicum*, synonyme du no[m] donné plus généralement, lui provient de l'en[]droit de sa première culture, la Lombardie. George Sinclair, à qui nous devons beaucou[p] de renseignements précieux sur la cultur[e] fourragère au commencement du dernie[r] siècle, ne le connaissait pas en 1826. Andr[é] Thouin cultivait le ray-grass italien, e[n] France, en 1818, mais c'est surtout grâce au[x] efforts de Mathieu de Dombasle qu'il devin[t] populaire dans ce pays. Les écrivains fran[]cais de cette période l'appellent la reine de[s] prairies. En Angleterre elle s'est répandu[e] surtout après que William Dickinson publi[a] les rendements fabuleux qu'il obtint en don[]nant de très fortes applications d'engrais. E[n] Amérique son utilisation agricole est presqu[e] limitée aux Etats de Washington et d'Orégon.

La graine du ray-grass italien provient d[e] l'Europe occidentale, de l'Argentine et de l[a] Nouvelle Zélande.

La Fétuque des près. *(Festuca elatior* L.*)*

Du nombre assez élevé de plantes four[]ragères de moindre importance, nous nous bor[]

nons à mentionner la fétuque des près. Recommandée aux agriculteurs suédois par le fameux botaniste Linné, dans sa "Flora suevica", et par Kalm, au dix-huitième siècle, la fétuque s'est montrée une plante de grande valeur. Sa distribution cependant, n'est pas très générale. En Amérique elle est presque inconnue excepté dans quelques comtés du Kansas, qui produisent presque la totalité de la récolte mondiale de graine. Celle-ci provient aussi du Danemark, de l'Allemagne, et de la Suède.

Ces quelques notes sur l'histoire de nos plantes fourragères montrent que beaucoup d'entre elles sont des acquisitions très récentes de la flore sauvage, de sorte qu'elles ont été très peu modifiées par la culture et la sélection, en contraste marqué avec les céréales et les plantes horticoles. A présent une confusion déplorable existe quant à l'interprétation des termes "nationalité", "variété", ou "sélection", tels qu'appliqués à ces plantes, même par des techniciens. Mais du bon travail a déjà été accompli par certains sélectionneurs, et nous sommes surs que dans un futur peu éloigné la culture fourragère prendra un nouvel essor par la création de variétés et de sélections supérieures. Dans tous les efforts qu'on fait pour introduire la production de semences fourragères au Canada, n'oublions pas cette phase importante de la question. Pour conquérir les marchés étrangers, pour nos graines, il nous faudra nécessairement en fournir qui produisent de bonnes récoltes fourragères sous les conditions des pays qui les achèteront, et la seule garantie d'obtenir ce résultat est de nous procurer de la semence de souche d'élite, de sélectionneurs de ces pays mêmes. Malheureusement, la production commerciale de la graine, jusqu-à présent, a plutôt eu la tendence de favoriser des sélections naturelles qui donnent de forts rendements en graine, trop souvent au détriment des qualités de la sélection au point de vue de la production fourragère. Cette erreur reconnue, et application faite des remèdes nécessaires, nous serons prêts à écrire un nouveau chapitre de l'histoire des plantes fourragères, et nous croyons que ce sera le chapitre le plus important et le plus profitable pour l'agriculture.

Activités des Sections.

Section de Montréal

Le banquet des sections réunies de la province de Québec, organisé au Cercle Universitaire de Montréal, le mardi 2 novembre, a été un succès sans précédent. A la table d'honneur avaient pris place les deux hôtes d'honneur et orateurs officiels de la soirée: l'Honorable J. Ed. Caron, Ministre de l'agriculture de la province de Québec, à droite du président, et le professeur Barton, Doyen de la Faculté d'agriculture de l'Université McGill, à gauche.

On y remarquait, en outre, Dom Pacôme Gaboury, Abbé de la Trappe d'Oka, Mgr. Piette, Recteur de l'université de Montréal, Monsieur Edouard Montpetit, Secrétaire général de l'Université de Montréal, le Dteur. Charron, Sous-Ministre adjoint du Département de l'agriculture d'Ottawa, Monsieur L. Ph. Roy, vice-président général de la C.S. T.A., Messieurs J. Ch. Magnan, E. A. Lods, et Ant. Ste. Marie, présidents respectifs des sections de Québec, du collège Macdonald et de Ste. Anne de la Pocatière.

Soixante et treize autres convives se pressaient autour des tables disposées dans la grande salle à manger du restaurant du Cercle Universitaire.

Au dessert, Monsieur H. M. Nagant, qui présidait le banquet, se leva, fit connaitre l'occasion de cette réunion, et présenta l'Honorable J. Ed. Caron, faisant ressortir sa longue et féconde carrière comme ministre de l'Agriculture de la province de Québec. Il fit une brève énumération des principales oeuvres d'organisation technique agricole, crécés ou développées sous son ministère, telles que le Service des agronomes de district, ceux de la Grande culture, de l'Horticulture de l'Industrie laitière, de l'Industrie animale, et rappela l'aide accordée à l'enseignement Agricole Supérieur, ces dernières années. Il insista encore sur le but de l'association des techniciens agricoles du Dominion, et des sections qu'elle possède dans les diverses provinces. L'objet des diners mensuels de la section de Montréal est de faire profiter ses membres de l'atmosphère scientifique de l'Université et, en même temps, d'intéresser

davantage les milieux universitaires et sociaux aux problêmes de l'agriculture et de sa technique. Ce soir nous avons l'avantage de pouvoir organiser un banquet des quatre sections de la province de Québec réunies, et les membres seront particulièrement heureux et fiers d'entendre comme orateur officiel l'Honorable J. Ed. Caron.

Ce fut au milieu d'une salve d'applaudissements que le ministre de l'agriculture se leva, et fit la magistrale conférence, dont le texte fut publié en grande partie dans les journaux quotidiens du lendemain, traitant notamment de la situation actuelle de l'agriculture dans la province de Québec, de l'importance de l'enseignement agricole et d'impressions rapportées sur l'agriculture telle qu'observée au cours d'un voyage en Europe, l'été dernier.

Monsieur J. Ch. Magnan, Agronome officiel à St. Casimir, comté de Portneuf, répondit à Monsieur le ministre Caron et lui adressa des remerciements au nom des membres de la C.S.T.A.

Après cela, ce fut le tour au professeur Barton, Doyen de la Faculté d'Agriculture de l'Université McGill, d'être présenté comme conférencier officiel de langue anglaise.

Le Doyen Barton fit un exposé très substantiel et fort apprécié de quelques problèmes actuels de l'agriculture dans la province de Québec, et de certains aspects de la technique agricole. Monsieur E. A. Lods, professeur au Collège Macdonald, et Président de la section de ce collège, remercia le Doyen Barton et parla au nom de la section anglaise de la province de Québec.

A Onze heures et demie, les convives se séparèrent sous le charme des allocutions de Mgr. Piette, Recteur de l'Université de Montréal et de monsieur Edouard Montpetit, Secrétaire général de l'Université, qui cloturèrent dignement la série des discours.

H.M.N.

Book Reviews

Plant Nutrition and Crop Production, by E. J. Russell. (University of California Press, Berkeley, California 1926.)

Plant Nutrition and Crop Production is just announced by the University of California Press. This book consists of five lectures delivered by Sir E. J. Russell, Director of Rothamsted Experimntal Station in 1924, when he was Hitchcock Lecturer at the University of California. There are 115 pages, 21 plates and 37 tables. The material is presented in five chapters under the following titles:

Chapter I.—The Study of Plant Nutrients.

Chapter II—Positive Science and Exact Demonstration.

Chapter III—Decay and the Living Plant: *Mors Janua Vitae.*

Chapter IV — The Soil Microörganisms: Can They Be Controlled and Utilized?

Chapter V—The Soil and the Living Plant.

Plant Nutrition and Crop Production is the first complete and comprehensive account of the development of Soil Science. It is written in the extremely interesting style which characterizes all the writings of Sir John Russell and is equally well suited for the investigator, lecturer and the student. While the mere reading of the book is intensely interesting, its greatest value is to be found in the stimulus it imparts to the student of research.

Every investigator and lecturer in the various branches of Soil Science should have access to this book. It should likewise be accessible to undergraduate students in soils and plant nutrition.

—F. A. Wyatt.

Concerning the C.S.T.A.

APPLICATIONS FOR MEMBERSHIP

The following applications for regular membership have been accepted since July 1st, 1926:—

Asplund, C.O. (Alberta, 1926, B.S.A.) Barnwell, Alta.

Bedford, R.H. (Alberta, 1926, B.S.A.) Edmonton, Alta.

Benoit, C.E. (Montreal, 1924, B.S.A.) Ottawa.

Berard, H.L. (Montreal, 1926, B.S.A.) St. Hyacinth, P.Q.

Caron, R. (Laval, 1925, B.S.A.) Lachute, P.Q.

Coleman, L.C. (Toronto, 1904, B.A.; Goettingen, 1907, Ph.D.) Toronto, Ont.

Davies, W. D. (Manitoba, 1924, B.S.A.) Strathmore, Alta.

Godbout, F. (Laval, 1925, B.S.A.) Montreal, P.Q.

Johnson, E. (Alberta, 1926, B.S.A.) Edmonton, Alta.

Lane, G.R. (Toronto, 1924, B.S.A., 1926, B.Sc.F.) Toronto, Ont.

Lanthier, J.D. (McGill, 1925, B.S.A.) Ottawa.

Lavoie, C.H. (Laval, 1924, B.S.A.) Mont Joli, P.Q.

Levine, W. (McGill, 1926, B.S.A.) Trout Lake, P.Q.

Manson, J.M. (Alberta, 1926, B.S.A.) Edmonton, Alta.

Michaud, J. (Laval, 1925, B.S.A.) Rimouski, P.Q.

Moar. R. (Saskatcheewan, 1926, B.S.A.) Semans, Sask.

MacLeod, H.S. (Toronto, 1926, B.S.A.) Saskatoon, Sask.

McCannel, D.A. (Alberta, 1924, B.S.A.) Edmonton, Alta.

McCurrach, B. (British Columbia, 1926, B.S.A.) Westholme, B.C.

Perrault, C. (McGill, 1926, B.S.A.) Macdonald College, P.Q.

Phillips, H.H. (Alberta, 1926, B.S.A.) Langdon, Alta.

Prior, K.L. (Alberta, 1926, B.S.A.) Central Africa.

Robinson, W. (Alberta, 1926, B.S.A.) Edmonton, Alta.

Roy, P. O. (Montreal, 1926, B.S.A.—St. Valier, P.Q.

Russell, Miss G. (McGill, 1926, B.S.A.) Macdonald College, P.Q.

Smith, J.B. (Toronto, 1923, B.S.A.) Toronto, Ont.

Thompson, D.W. (British Columbia, 1926, B.S.A.) Eburne, B.C.

Tinline, M.J. (Manitoba, 1911, B.S.A.) Brandon, Man.

Vernon, C.G. (Alberta, 1926, B.S.A.) Craigmyle, Alta.

Walford, S.M. (McGill, 1926, B.S.A.) Broad Acres, Conn.

West, Roy (Manitoba, 1926, B.S.A.) Estevan, Sask.

Whitmore, J.E.D. (Toronto, 1926, B.S.A.) Ottawa, Ont.

Williamson, W.H. (Toronto, 1923, B.S.A.) Georgetown, Ont.

Woolliams, G.E. (British Columbia, 1925, B.S.A.; Idaho, 1926, M.Sc.) Summerland, B.C.

The C.S.T.A. membership list now contains the names of 937 regular members, and 9 student members, a total of 946. It is probable that this list will be increased considerably during the month of December. A complete classified list will be printed and distributed immediately after the New Year.

NOTES

Dr. G. C. Creelman, President of tht Society, is leaving for Western Canada on December 6th. He will spend Christmas with his daughter in Edmonton (Mrs. N. Curtis), after which he intends to remain in Vancouver or Victoria until next June when the Seventh Annual Convention of the Society is being held at Vancouver.

J. M. Trueman (Cornell '95) has been appointed Director of Agricultural Extension in the Nova Scotia Dept. of Agriculture. His position at the Truro Agricultural College—Professor of Animal Husbandry—which he had occupied since 1913 has been filled by the appointment of F. W. Walsh (O.A.C. '22), formerly District Sheep and Swine Promoter at Truro.

E. A. Atwell (Macdonald, '23) is on the staff of the Dominion Laboratory of Plant Pathology at Fredericton, N.B.

E. F. Neff (O.A.C. '15) has been transferred as Agricultural Representative from Leed County to Lincoln County. His new headquarters are at St. Catherines, Ont., where he succeeds W. S. Van Every (O.A.C. '22), now in the insurance business.

K. L. Prior (Alberta '26) has left for Central Africa where he intends to take up missionary work.

A. R. Milne (Macdonald '22) has been appointed to the Emigration Dept. of the Canadian National Railways, London, England. His former position of Field Superviser, under the Soldier Settlement Board at St. Catharines, Ont., has been accepted by P. C. Connon (O.A.C. 20).

A. C. Wilson (O.A.C. '97) has purchased a half interest in a seed and floral company at Springfield, Ill., to be known as the Wilson-Morgan Seed and Floral Co. His address is 1512 S. Fourth St., Springfield, Ill.

MEMBERSHIP FEES

Those who do not hold membership cards for the year ending June, 1927, are requested to send their renewal fee now to their local secretary or direct to the General Secretary. The reduction in fees from $6.00 to $5.00 makes it more imperative than ever that the lower fee be paid promptly and willingly.

AGRICULTURAL BOOKS

When members are ordering agricultural books through the office of the General Secretary, they are requested to furnish the name of the author and publisher, as well as the title of the book. By attending to this detail they will be doing a service to themselves as well as to the Secretary.

WESTERN ONTARIO LOCAL

The first of the semi-monthly meetings of this local is being held at the Engineer's Club, Toronto, on December 3rd, when Dr. Creelman will give an account of his recent visit to the C.S.T.A. locals in Quebec.

ROYAL WINTER FAIR BANQUET.

One hundred and forty O.A.C. Alumni and C.S.T.A. members attended the joint banquet held at the King Edward Hotel on November 17th. The chief speaker was Dr. Coleman, Professor of Geology at the University of Toronto. Entertainment was provided by Mr. George Patton, the O.A.C. quartette and others.

OTTAWA WINTER FAIR BANQUET

The O.A.C. Alumni Association held a banquet at the Chateau Laurier, Ottawa, on November 24th, when eighty graduates were in attendance. The guest of honor, and speaker, was Prof. H. L. Fulmer of the O.A.C. Other guests included the officers of the Eastern Ontario Branch of the C.S.T.A., and the General Secretary. Many interesting re-unions, of a smaller and more informal nature, took place after the close of the banquet.

Field Experiments on the Control of Stem Rust by Sulphur Dust.*

D. L. BAILEY and F. J. GREANEY

Dominion Rust Research Laboratory, Manitoba Agricultural College. Winnipeg, Man.

Preliminary experiments at this laboratory in 1925 (1) on the control of stem rust of wheat by dusting with sulphur gave such promising results that further experiments were undertaken this year. These consisted of small plot experiments similar to those of last year and some preliminary field trials in which a horse-drawn traction duster was used.

In the small plot experiments, particular attention was given to the number of applications necessary to control rust, and to the most effective time of applying the dust. The object of the field experiments was to test (1) the efficiency and practicability of using sulphur for dusting larger areas and (2) to determine the least number of applications of dust necessary to control leaf and stem rusts of wheat in a natural epidemic.

The field experiments were conducted only in Manitoba, since Manitoba suffers proportionately more serious rust losses than the provinces farther west. Wheat is extensively grown in the Portage Plains district of Manitoba and the selection of a field for carrying on an experiment in that locality was therefore desirable. Accordingly, a field of wheat located on the farm of Mr. J. Sanderson, Portage la Prairie, Manitoba, was chosen for a series of dusting experiments. A second series of field trials was carried out on the farm of Mr. Perrault, St. Norbert, Manitoba. We were fortunate in securing the cooperation of Mr. Perrault, as the field selected was growing under conditions typical of the wheat-growing area of the Red River Valley.

The writers wish to express their appreciation to Mr. Sanderson and Mr. Perreault for their valuable cooperation and interest in the experiments.

EXPERIMENTAL METHODS

Winnipeg Plot Experiments

In 1926, the small plot experiments were similar to those carried on last year. A block of heavy clay loam soil previously summer-fallowed was sown with Marquis wheat. After the young plants had appeared well above ground, the block was divided into thirteen one-fortieth acre plots, separated from one another by three-foot pathways.

Three of the plots remained untreated as checks. One plot was dusted at the rate of 45 lbs. per acre every two weeks throughout the dusting period, July 5th to August 6th. The remaining nine plots were divided into three series of three plots each. In the first series one plot was dusted at the approximate rate of 15 lbs. of sulphur dust per acre at each of the following frequencies; (1) One dusting every week, (2) two dustings every week, and (3) three dustings every week. Dusting operations for this series were begun July 5th. At that time, not a trace of stem rust had been found in the district, although a very light infection of leaf rust was present in the plots. The first evidence of stem rust in Manitoba was reported from Morden Experimental Station on June 30th. A second series was dusted at the same rate and at the same frequencies but in this case the dusting was not begun until July 25th. By this time a light infection of stem rust and a very general infection of leaf rust had been reported from the southern wheat-growing sections of the Province. The third series of plots was dusted whenever rain seemed imminent. One of these plots was dusted at the rate of approximately 15 lbs. per acre, another at 30 lbs. per acre, and the third one at 45 lbs. per acre.

In the small plot work a hand duster (Niagara Blower-Gun, No. 42) was used. The sulphur dust was Niagara Sulphodust No. 134, supplied by the Niagara Sprayer Co., of Middleport, N.Y. This dust proved to be very effective in last year's trials.

The final data were taken on stem rust infection on August 7th. Yield data were

*Contribution from the Division of Botany, Experimental Farms Branch, Department of Agriculture, Ottawa, Canada.

collected from the various plots by harvesting from each plot three samples, each covering one square yard in area. The average of the three samples was taken as the yield of the plot.

Portage la Prairie Field Trial

The field selected on the Portage Plains consisted of eighteen acres of Ruby wheat. The wheat was sown early on a rich clay loam soil which had been summer-fallowed the previous year. The growth of the plants was vigorous and extremely uniform over the entire area. Seventy-five per cent of the plants were headed out when dusting was begun on July 7th.

Four one-acre plots were selected from this eighteen acre field. These were widely separated in order to avoid any effect from drifting of the sulphur dust from one plot to another during the dusting. Representative areas which remained untreated were used as checks.

One plot was dusted once every week at the rate of approximately 30 lbs. sulphur dust per acre. Dust was applied to the second plot at the rate of 15 lbs. per acre, twice every week. Dusting of these plots was begun on July 7th. At this time rust was not general in the Portage district and it required a careful search to locate the scattered primary infections which were present. On the other two plots dusting was not begun until July 20th, which was two weeks later than in the previous ones. By July 30th a very light infection of stem rust could be found in many of the neighboring fields.

The sulphur dust was applied by means of a horse-drawn traction dusting machine, which was generously lent to the Department by the Niagara Sprayer Company, of Middleport, N.Y. This machine was a "Niagara Heavy Duty Traction Crop Duster, C-26-P," specially designed for dusting low crops. The power was secured from two large wheels equipped with ratchets, and was transmitted to the working parts by three chains. Field dusting was done by the broadcast method. A cloud of dust was forced through a four-inch discharge pipe and distributed over the field as the machine was drawn along. With favorable atmosphere conditions the machine would dust effectively a swath of fifty to sixty feet in width. This type of machine proved satisfactory for experimental purposes. For extensive field operations a machine with a considerably larger blower and discharge attachment would be essential.

Close observations were made on the spread and development of stem rust during the dusting period (July 7th—August 3rd). The first pustule was found in this field on July 9th and at this time a light infection of leaf rust was also present. Stem rust developed very slowly during the season.

Final data on rust infection were taken on August 6th. In all the experiments estimates of stem rust infection were made according to the system followed by the United States Department of Agriculture. Due to the light and variable infection on all of the plots, these readings were taken with considerable difficulty.

At harvest time twenty rod rows were harvested from each plot in the series which received the earlier application of dust. The average of the twenty samples of one rod each was taken for calculating the yields of each plot.

St. Norbert Field Trial

This field consisted of twenty acres of Marquis wheat growing on clay soil, typical of the Red River Valley.

Three one-acre plots were selected for dusting while two larger plots remained untreated and were used as checks. One of the acre-plots and one of the check plots were located on soil which had grown potatoes the previous year. The acre-plot was dusted once every week at the rate of 30 lbs. of sulphur dust per acre. The second series, which consisted of two one-acre plots and a check plot, was located on soil which had been summer-fallowed the previous year. One of the plots was dusted twice every week at the rate of 15 lbs. per acre with Niagara Sulphodust No. 134. The second plot was given the same treatment except that in this case, a recently developed dust—Niagara Kolo Dust—which is highly recommended for its great adhesive properties, was applied.

The first application of dust was made on July 3rd, and the dustings were continued until July 31st. Stem rust was not found in this field until July 6th. The dust was applied by means of the Niagara Traction Crop Duster already described.

EXPERIMENTAL RESULTS

Winnipeg Plot Experiments

The results of the small plot experiments re summarized in Table 1. It will be noticed t once that the infection of stem rust on the intreated check plots was very light and varable, ranging from a mere trace to a maxinum of 25 per cent. Under such conditions he experiment was obviously no test of the ffectiveness of sulphur dust in controlling tem rust under epidemic conditions in the ield. Nevertheless, the semi-weekly and trieekly applications had a very noticeable ffect in checking the development of rust nd they achieved a measure of control coniderably more perfect than would be necesary in general practice. Since the check plots were not heavily enough rusted to be appreciably reduced in yield, it was not to be expected that even the most perfect control of rust achieved would increase the yield.

While the experiment was not satisfactory as a test of rust control, it afforded a good opportunity to investigate the influence of sulphur dust on the yield of wheat in the absence of significant amounts of stem rust. For this reason yield data were collected from the various plots and are presented in Table I. Considering the fluctuation in the yields of the untreated check plots, the variation in the yields of the treated ones is evidently of no special significance. Therefore, it must be concluded that dusting wheat with sulphur had little if any direct influence this year on the yield.

TABLE 1.

Results of Dusting Wheat with Sulphur for the Control of Stem Rust at Winnipeg, Man., in 1926.

Series	DUSTING PERIOD July 5th to Aug. 6th — Applications— Rate: lbs. per acre	Frequency	Total Number	Percentage infection of stem rust	Yield per acre in bushels
1	15	Weekly	5	tr - 10	41.6
	15	Semi-weekly	11	tr	43.2
	15	Tri-weekly	15	tr	42.8
	Check	0	0	tr - 10	45.1
2	15	Weekly	2	5	41.6
	15	Semi-weekly	4	5	45.1
	15	Tri-weekly	6	tr - 5	45.0
	Check	0	0	tr - 15	37.9
3	15	Just before rains	5	tr - 5	41.4
	30	"	4	tr - 5	35.0
	45	"	5	tr	32.5
	Check	0	0	10 - 25	39.2
	45	Fortnightly	3	tr - 10	43.0

Portage la Prairie Field Trial

The results of the Portage experiment are ummarized in Table 2. The plot which was lusted weekly, or five times altogether, at he approximate rate of 30 lbs. of sulphur er acre yielded four and one-half bushels er acre more than the check. This was a triking increase considering the light infecion of rust present in the check. The plot, which was dusted twice a week, or nine times ltogether, at the rate of 15 lbs. per acre, lid not yield any higher than the check, although rust did not seem much heavier on this plot than on the one which gave the higher yield. Where the infection is so light and variable, however, it is very difficult to determine accurately slight differences in the severity of the attack over such large areas. While there may be some doubt as to whether the increased yield in the one case was due entirely to reduced rust infection, there was no question that rust was significantly held in check in both the treated plots as compared with the untreated ones. This differ-

TABLE 2.

Results of Field Trials of Dusting Wheat with Sulphur for the Control of Stem Rust at Portage la Prairie, Man., in 1926.

DUSTING PERIOD July 3rd to Aug. 3rd			Percentage infection of stem rust	Yield per acre in bushels
Applications				
Rate: lbs. per acre	Frequency	Total Number		
30	Weekly	5	5-10	29.0
15	Semi-weekly	9	5-15	25.1
Check	0	0	5-20	24.5

ence was distinct when the crop had still three weeks to mature and it seemed certain that the difference would be greatly accentuated during that interval. But hot dry weather with strong winds followed and this not only hastened the maturity of the wheat but inhibited further rust development. Considering all these circumstances the results which were obtained seemed to support those obtained last year indicating that this treatment is effective in controlling rust under field conditions.

St. Norbert Field Trial

The results of the St. Norbert experiment are summarized in Table 3, and are ver comparable with those obtained at Portage The crop on soil which grew potatoes las year grew much more rank, was somewha later in maturing than the ordinary summer fallow crop, and was therefore more heavil rusted. It will be noticed that five applica tions of sulphur dust at the rate of 30 lbs per acre practically controlled rust on th test plot on potato soil and that this plo yielded five bushels per acre more than th check. The crop on summer-fallow matured so early that even on the untreated plots rus scarcely developed at all.

TABLE 3.

Results of Field Trials of Dusting Wheat with Sulphur for the Control of Stem Rust at St. Norbert, Man., in 1926.

Cultural condition of field in 1925.	DUSTING PERIOD July 7th to July 31st			Percentage infection of stem rust	Yield per acre in bushels
	Applications				
	Rate: lbs. per acre	Frequency	Total Number		
Potatoes	30	Weekly	5	5	44.6
"	Check	0	0	20-30	39.4
Summer-fallow	15	Semi-weekly	9	5-10	27.2
"	Check	0	0	10	23.6
"	15 (Kolo dust)	Semi-weekly	9	10	25.2

DISCUSSION

Stem rust was a negligible factor in Manitoba this year due apparently to unfavorable environmental conditions and to scarcity of inoculum. Consequently, the season was not a satisfactory one to test the efficiency of sulphur dusting for the control of stem rust under field conditions. Such results as were obtained, however, were distinctly promising as far as the efficiency of the method is concerned, although they did not yield much data as to its practicability.

The experience of this summer in field dusting emphasized the difficulties which would be met with in extending this method of control to general use. It does not seem probable in the light of the heavy losses caused by rust that the cost of the sulphur would prove a limiting factor. Therefore there remains only the solution of the practical difficulties incidental to applying the dust economically and effectively without mechanical injury to the standing crop. These difficulties should not prove insurmountable.

LITERATURE CITED

1. Bailey, D.L. and F.J. Greaney. Preliminary experiments on the control of leaf and stem rust of wheat by sulphur dust. Sci. Agri. 6:113-117. 1925.

An Interesting Instance of Root Penetration.

G. P. McROSTIE, R. I. HAMILTON and N. LUNDBLAD

Forage Crop Division, Central Experimental Farm, Ottawa, Ontario

That the roots of plants have a wonderful ability to penetrate is common knowledge. This is exemplified by the common spring-time sight of a tender young sprout lifting in its growth large pieces of earth many times its own weight. Digging in the soil one also finds occasional examples of slender rootlets penetrating rock crevices and ultimately splitting fairly large stones.

The penetration of foreign plant tissues is not so commonly observed by the novice but nevertheless frequently occurs. In soil where couch grass is prevalent one finds the underground stems of this plant occasionally growing through the tissues of surrounding vegetation.

The writers have observed this phenomenon on different occasions in connection with a piece of couch grass infected soil on which sunflowers had been planted. The underground stems of the grass had grown all the way through the underground portion of sunflower stalks without any apparent inconvenience to either grass or sunflower.

During the last harvesting season a new case of penetration came to light when field carrots were being harvested. One carrot was discovered that was pierced by an underground stem of couch grass. The accompanying cuts will illustrate the apparent normal development of both root and undergrowing stem subsequent to the initial penetration.

Some definite data as to the length of time that it took for the underground stem of the grass to penetrate entirely through the root of the carrot would be very interesting. The writers have not been fortunate enough, however, to locate much phenomena during the course of penetration and are therefore not in a position to offer evidence relating to the point mentioned.

Physiologic Forms of Wheat Stem Rust in Western Canada.*

MARGARET NEWTON and THORVALDUR JOHNSON

Dominion Rust Research Laboratory, Manitoba Agricultural College, Winnipeg.

In earlier papers (1, 2, 4, 5, 6) it was reported that fourteen physiologic forms of *Puccinia graminis tritici* (Pers.) Erikss. & Henn., had been demonstrated by greenhouse experiments to be present in Western Canada. These forms, as well as some others, had previously been isolated in the United States by Stakman and his colleagues.

Since 1919, the year in which the first forms were isolated in Canada, the most intensive work in this country on physiologic specialization has been done at the Dominion Laboratory of Plant Pathology at the University of Saskatchewan. With the building of the Dominion Rust Laboratory at Winnipeg in 1925, the greater part of the work on physiologic specialization was transferred to that station, where with more field men and greater greenhouse accommodation the work can be carried out on a more extensive scale.

As was pointed out in earlier papers, the discovery of the occurrence of more than one physiologic form of stem rust was not only of scientific interest, but had a direct bearing on the breeding of grain for rust resistance. It showed why "few varieties seem to be universally rust resistant, and explained the diverse opinions of workers in different localities as to the relative rust resistance of certain wheat varieties"(3). Indeed, it demonstrated clearly that a study of biologic forms must precede the breeding of rust resistant wheats.

Object of Work

The object of this work, then, was to gain a definite knowledge of the number, characteristics and geographical distribution of all the physiological forms in Canada—information absolutely necessary before the plant breeder can be assured of effective results in producing resistant varieties of wheat.

Materials and Methods

Accordingly, extensive collections of stem rust on wheat, barley and wild grasses were made in all the grain growing areas of Western Canada. In this connection must be mentioned the splendid collecting ground provided by the rust nurseries. These plots were designed especially for the purpose of testing the relative resistance of many varieties of wheat to stem rust (See Report of the Division of Botany, 1924: 65-67), and were carried on coöperatively by the Dominion Experimental Farms and Western Universities. Often, due to the great variety of wheats found therein, they acted as ideal spore traps for new and unusual physiological forms.

All the work of differentiating the numerous rust collections into distinct forms was carried out in the greenhouse, where conditions could be more definitely controlled than in the field.

The methods of inoculating and culturing the rusts were similar to those described by Stakman and Piemeisel (8) and the key used for the identification of the various forms was that devised by Stakman and Levine (10) in their work on physiologic specialization.

Results

In Tables 1 and 2 are given summaries of the information relating to the forms isolated from 1919 to 1925. This includes a statement of the number of times each form was collected annually, and the number of collections of rust made each year. Table 3 contains a summary of the distribution by provinces of the physiologic forms of stem rust in 1925.

Discussion of Results

As will be seen in Tables 1 and 2, seventeen physiologic forms have been demonstrated by greenhouse experiments to be present in Western Canada. These forms have proved to be identical with some of those described by Stakman in the United States. In the latter country, however, twenty addi-

*Contribution from the Division of Botany, Experimental Farms Branch, Department of Agriculture, Ottawa, Canada.

TABLE 1.

Annual occurrence of physiologic forms of *Puccinia graminis tritici* in Western Canada from 1919 to 1925 with a record of number of times each form was collected annually.

Year	Number of times Form was Collected.						
	1919	1920	1921	1922	1923	1924	1925
Form 1	2	1	—	—	—	—	—
" 2	—	—	—	—	1	—	—
" 3	—	4	3	10	10	16	—
" 9	4	6	2	3	—	—	—
" 11	2	5	2	3	5	9	—
" 12	—	2	—	—	—	5	—
" 15	1	—	—	—	—	—	—
" 17	9	31	27	16	10	1	—
" 18	4	7	3	2	—	—	—
" 19	1	—	—	—	—	—	—
" 21	4	—	4	24	—	1	44
" 24	1	—	1	—	—	—	—
" 29	—	17	1	—	—	—	13
" 30	—	1	—	—	—	—	1
" 32	—	4	1	—	—	—	3
" 34	—	—	—	1	3	7	1
" 36	—	—	—	2	—	—	113
Total No. of forms	9	10	9	8	5	6	6
Total No. of collections made in year	28	78	44	61	29	39	175

TABLE 2.

The relation between the total number of collections of *Puccinia graminis tritici* made in Western Canada each year, and the number of physiologic forms isolated.

Year	No. of Collections	No. of Physiologic Forms
1919	28	9
1920	78	10
1921	44	9
1922	61	8
1923	29	5
1924	39	6
1925	175	6

Tables 1 and 2 are compiled from lit. cit'n. (1, 6) and from unpublished data of the authors.

TABLE 3.

Distribution by Provinces of the physiologic forms of *P. graminis tritici* in Western Canada in 1925.

Province	No. of Times Form was Collected.				Total No. of times each form was collected
	Extreme Western Ontario	Manitoba	Saskatchewan	Alberta	
Form 21	2	35	5	2	44
" 29	—	11	2	—	13
" 30	—	1	—	—	1
" 32	—	2	1	—	3
" 34	—	1	—	—	1
" 36	4	76	26	7	113
Total No. of collections made	6	126	34	9	175

tional forms have been shown to be present (10).

There seems to be no correlation between the number of collections made each season and the number of forms isolated. In 1919, twenty-eight collections were made and nine physiologic forms isolated; in 1925, one hundred and seventy-five collections were made and only six forms isolated. Further from 1919 to 1921, the average number of forms shown to be present in Canada was nine, while from 1923 to 1925 the average number was only five, results that would seem to suggest that, for some unknown reason, physiologic forms in Western Canada are becoming fewer in number.

Another striking feature made evident by this work is the fact that different physiologic forms predominate in different years. From 1919 to 1921, form 17 was the predominating one and form 21 occurred only rarely; from 1921 to 1925, the reverse has been true. Form 17 disappeared in 1925, while form 21 became one of the most prevalent forms. In the same way, a form, for example form 1, may appear for a season or two, and then disappear for a series of years; or again, as with form 3, it may appear so consistently, year after year, as to be looked upon as a permanent form, and then, without any apparent cause, it may suddenly disappear.

The question naturally arises, do the less virulent forms tend to disappear and the more virulent forms gain the ascendancy? Nothing in the work so far has suggested that this is the case, as form 15, the most virulent of all the forms collected in Canada or the United States, appeared but once in Canada. Why it should not have remained is still a mystery, as it was able to infect severely all but one of the wheats to which it was tested. This resistant wheat was Khapli, an emmer from India, which possesses a very high degree of resistance to all Canadian forms. During the past year, the prevailing forms were 36 and 21, the former being three times as common as was the latter. Should antagonism exist among physiologic forms, and the more virulent ones tend to overcome the weaker, then 21, the more virulent of these two forms should be more common than 36, as the former can infect a number of durums which remain immune to the latter form. With our present knowledge of physiologic forms, therefore, all that can be said is tha there seems to be no correlation between th virulence of the form, and the frequency o its appearance.

The past seven years' work has shown tha relatively few physiologic forms seem to b present in Western Canada in any one season Although in the summer of 1925, rust wa collected in one hundred and seventy-five dif ferent localities in the west, ninety per cent of these collections have been shown to b either form 36 or form 21, often a combina tion of both. These two forms were by fa the most widely distributed of all those isolat ed, being found in distantly separated dis tricts of Ontario, Manitoba, Saskatchewan and Alberta which embrace a variety o climatic conditions, especially in regard to rainfall. Thus, although Canada often suf fers very severe losses due to the ravage of the stem rust organism, a small numbe of forms are apparently responsible for th injury.

SUMMARY

1. Seventeen physiologic forms have been isolated in Western Canada during the per iod 1919-1925.
2. The work has indicated there is no corre lation between the number of collection made each season and the number of form isolated.
3. Different physiologic forms predominat in different years.
4. Virulent forms do not appear to overcom and destroy less virulent forms.
5. Relatively few physiologic forms hav been found present in Western Canada i any one season.

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Greenhouse Experiments on the Relative Susceptibility of Spring Wheat Varieties to Seven Physiologic Forms of Wheat Stem Rust.*

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Stem rust, *Puccinia graminis tritici* (Pers.) ;rikes. & Henn., has for many years been he most destructive parasite of wheat in Vestern Canada. All the spring wheat varieties which are commonly grown are inherntly susceptible, though some may occasionlly escape damages on account of early ripning. Because of the ravages of stem rust, armers in many parts of Manitoba have ractically given up growing common wheat arieties, replacing these by durum wheats, which have generally shown more resistance.

Of late years many attempts have been nade, in the United States and Canada, to roduce varieties of common wheat resistant o rust. While many of these new varieties ave shown considerable promise, none of hem has completely solved the problem. The Dominion Department of Agriculture, hrough the establishment of a Rust Research aboratory at Wininpeg, is making a serious ffort to develop common wheat varieties of atisfactory quality which at the same time vill have adequate resistance. This is being ttempted through combining the resistance of nany partially resistant common wheat varieties.

This procedure raises at once the problem of testing the rust resistance of all promising varieties which are available. This has often presented great difficulties, for the same variety may show various degrees of resistance in different localities, or may appear to fluctuate in its resistance from year to year. In some instances these discrepancies may be attributable to the presence of distinct forms of the rust organism in different localities; furthermore, the same physiologic forms may not recur year after year. On the other hand, factors which we do not understand may be responsible for some of these differences.

The testing of these varieties, under controlled conditions in the greenhouse for their reactions to specific forms of stem rust, yields results which enable us to compare their inherent resistance. These varieties were grown under exactly the same conditions and tested simultaneously to each physiologic form of rust. This eliminates a host of factors about which we know nothing, and which occur in field tests. It is impossible to

*Contribution from the Division of Botany, Experimental Farms Branch, Department of Agriculture, Ottawa, Canada.

state what effect such factors as soil heterogeneity, soil moisture and temperature, air humidity, dates of planting, rates of seeding, etc., may have on rust infection in the field. This is further complicated by the presence of different physiologic forms of rust in different parts of the country. All these conditions are standardized in our greenhouse experiments.

The Scope of the Experiment

The experiment includes the testing of the reaction of 29 varieties of wheat to 7 physiologic forms of stem rust. This, of course, does not represent a complete test of their reactions to *Puccinia graminis tritici*, which includes upwards of 37 known physiologic forms (1). It does, however, comprise a test of the behaviour of these varieties to the physiologic forms which occur most commonly in the great plains region of the United States and Canada. Two of these forms, namely, 36 and 21 have been found in approximately 90 per cent. of the collections of wheat stem rust made in the three prairie provinces during the years 1925 and 1926.

The majority of the varieties tested have been developed recently, but for purposes of comparison some of the old standard varieties, such as Marquis and Kota, have been included.

Methods

The forms used in these experiments were collected in various parts of Canada in the summer of 1925. They were isolated and identified at the Dominion Rust Research Laboratory, Winnipeg, by the writers.

The plants of the different varieties were grown in four inch pots, ten to fifteen plants per pot, and were hand inoculated by pure cultures of each physiologic form, after which they were kept in moist chambers for 48 hours, to allow the rust spores to germinate and infect. They were then removed and placed in booths in the greenhouse, separated by glass partitions designed to eliminate draughts without interfering with the sunlight requirements of the plants. The temperature of the greenhouse was usually maintained between 60 and 75 degrees Fahrenheit. Twelve to fifteen days after inoculation the reactions of the plants were observed and recorded. The whole experiment was repeated until satisfactory results were obtained for each variety.

Explanation of Terms in Table

The following symbols, adapted from Stakman and Levine (1), are used in the Table to indicate the types and degrees of infection on the varieties tested.

Types of Infection

O indicates that plants are immune; no uredinia are developed and hypersensitive flecks are usually not present.

O; Plants are immune, no uredinia are developed, but hypersensitive flecks occur. The rust organism has entered the host tissues but the host is so uncongenial that development soon ceases.

1 Plants are very resistant. Uredinia are very small and surrounded by sharp, hypersensitive, necrotic areas.

2 Plants are moderately resistant. The uredinia are small to medium in size; hypersensitive areas present in the form of necrotic halos, surrounding green islands in the center of which the uredinia are usually located.

3 Plants are moderately susceptible. The uredinia are of medium size, sometimes but infrequently coalescing. Necrosis and hypersensitiveness are absent but chlorotic areas may surround the uredinia.

4 Plants are very susceptible. The uredinia are large and usually coalesce to form large irregular pustules. Hypersensitive and necrotic areas are absent but chlorotic areas may surround the pustules.

X Plants are heterogeneous in their reaction. All the above reactions may occur together on the same leaf. Certain physiologic forms react in this manner on some varieties, especially on some of the durum wheats.

Degree of Infection

(=) Trace. Uredinia are few and small and rust development poor.

(—) Slight. Rust development slightly better than "Trace".

(±) Degree of infection moderate for its type of infection.

(+) Degree of infection considerable. Infection above the normal of its type.

(++) Degree of infection abundant. The development of rust much above the normal for its type of infection.

Table I.—The reaction of 23 common wheat varieties and crosses, and 6 durum wheat varieties to 7 physiologic forms of *Puccinia graminis tritici*.

WHEATS TESTED	Host Reaction to Physiologic Forms 21		29		30		32		34		36		‡	
COMMON WHEAST														
†Axminster R.L. 75.	3±		4		4—	4	4+		3±	4	3+	4	3±	
Ceres R.L. 127 (C.I. 6900)	3+	4—	2+	3±	3—	4	3—		3±	4+	4—	4	2+	3±
N.D. 1656 R.L. 126,	3+	4—	2+	3	3+		2	3—	3	4	3+	4—	3±	
Garnet R.L. 15 (Ott. 652)	4+		4+		4	4+	...		4—	4+	4+		4	4+
Kota R.L. 221 (C.I. 5878)	3++		3		3+		3+		4=		3++		3	
Marquis C.I. 6364.	4		4—		4		4=		4—		4		2—	
Marquis x Kanred R.L. 52 (Minn. B-2-5)	0		0		0		4—		3+		3	3+	0	
MacFadden's Emmer R.L. 229 (H-44-24)	2+		2+		3—		—		—		0;	1	1	
McKenzie's Selection (Rustless) R.L. 232.	3±	4—	3+	4	3++	4	4		3	4—	3+	4	1±	3—
*Marquillo R.L. 132 (Minn. II-15-44)	1	3++	0;	3±	0;	3	0;	3—	0;	3±	3	4—	0;	1+
Parker's R.L. 71.	3+	4	3+	4+	3+	4+	4		3±	4	3+	4	0;	1+
Progress R.L. 206.	3±		3+	4	3++		3+	4	3++		3+		1	3
Quality R.L. 133.	3+	4	4—	4	3	4	4—		3+	4	3+	4—	1	3=
Red Quality A. R.L. 69	3+	4	3+	4	3+	4	4		4—	4	3+		1	1+
Red Fife x Smooth Spelt R.L. 88 (Ott. 682-B)	3+	4—	3+	4—	3+	4—	3+	4—	4—		3+		4—	
Red Russian R.L. 108. (Sask. 1030)	3+	4	2+	4—	3±		3+	4—	3	4—	3+	4	3+	
Reward R.L. 79 (Ott. 928)	3+	4	3+	4	4—	4	4		3+	4	4—	4	2	3
Ruby R.L. 12. (Ott. 623)	4+		4+		4+		4		4—	4+	4+		2+	3
Sevier x Dicklow R.L. 366 (G. 40)	3±		3+		3±		3		3	4—	3±		3=	3
" x " R.L. 367 (G. 84)	3±		3±		3±		3+		3±	4+	3±		2+	3
" x " R.L. 368 (G. 149)	2	3±	2	3	2	3±	2+		2+	3±	2	3—	2	3—
Warren R.L. 214.	4—		4		4		4—		4		3++		1+	
Webster R.L. 365 (C.I. 3780)	3—	3	3—	3	3—	3	3		3—	3	3—	3	3—	
DURUM WHEATS:														
*Iumillo R.L. 7.	0;		0;		0;		0:		0;		0;		0;	
Kubanka R.L. 3 (Ott. 37)	3+	4	X	3+	X	3+	3±	4	3+	4	X—	3++	X—	4—
Kubanka R.L. 125 (Sask. 45)	3+	4	3	4	3+		3+	4—	3+	4	3+		3—	4—
Monad R.L. 205 (D-1)	3+	4—	3±		3—		X—		3+		3—	4—	3—	3+
Pelissier R.L. 145. (Sask. 41)	3+	4	3+	4	3+	4—	4—		3++	4	3+	4—	3	4—
*Pentad R.L. 203 (D-5)	3±		0;	X—	0;	X—	0;		3+		0;	X—	3	X

* The varieties indicated by the asterisks were either genetically impure or mechanically mixed.
‡ This form appears to be a new one, but has not been identified definitely.
† R.L. numbers represent the accession numbers of the plant breeding department of the Dominion Rust Research Laboratory, at Winnipeg.

As examples of the above, 1= represents a higher degree of resistance than 1—, which in turn indicates a higher degree of resistance than 1. On the other hand 4++ indicates greater susceptibility than 4+, which again indicates greater susceptibility than 4.

Origin of Varieties Tested

Axminster, R.L. 75. This variety was developed by Mr. Samuel Larcombe, of Birtle, Manitoba.

Ceres, R.L. 127 (C.I. 6900). Formerly known as N.D. 1658. A North Dakota selection from a Marquis x Kota cross.

N.D. 1656. R.L. 126. A North Dakota selection from a Marquis x Kota cross. These two North Dakota selections were developed by Dr. L. R. Waldron of the North Dakota Agr. Exp. Station.

Garnet R.L. 15. (Ott. 652). From a cross made in 1905 between Preston A and Riga M.

Kota R.L. 221 (C.I. 58788). Obtained from Russia by Prof. H.L. Bolley, of the North Dakota Agricultural College, in 1903, as a mixture in a sample of durum wheat. In 1919 it was named Kota by Waldron and Clark.

Marquis C. I. 6364.

Marquis x Kanred R.L. 52. (Minn. B-2-5). A cross made by Dr. H. K. Hayes and Mr. O. Aamodt at the Minn. Agr. Exp. Station, St. Paul, Minn.

MacFadden's Emmer R.L. 229 (H-44-24). Developed from a Marquis x Yaroslav Emmer cross by H.S. MacFadden of Webster, South Dakota.

McKenzie's Selection (Rustless) R.L. 232. Developed by E.A.W.R. McKenzie, of Pelly, Sask.

Marquillo R.L. 132 (Minn. II-15-44). Developed from a Marquis x Iumillo cross made by Dr. H.K. Hayes and Mr. O. Aamodt at the Minn. Agr. Exp. Station, St. Paul, Minn.

Parker's R.L. 71. Selection made by Mr. J. L. Parker, Gilbert Plains, Man.

Progress R.L. 206.

Quality R.L. 133. Distribution by Luther Burbank of Santa Rosa, California, in 1918.

Red Quality A. R.L. 69. A red selection made at Ottawa from Burbank's Quality, which is a white wheat.

Red Fife x Smooth Pelt R.L. 88 (Ott. 682-B).

Red Russian R.L. 108 (Sask. 1030).

Reward R.L. 79 (Ott. 928).

Ruby R.L. 12 (Ott. 623). A cross between Downy Riga G. and Red Fife D.

Sevier x Dicklow R.L. 366 (G. 40)

Sevier x Dicklow R.L. 367 (G. 84)

Sevier x Dicklow R.L. 368 (G. 149)
Crosses made by Prof. Geo. Stewart, head of the Agronomy Dept., Agricultural College, Utah.

Warren R.L. 214. Developed by Dr. Knecthed of Souris, Manitoba.
The result of a cross between (Bobs x Jonathan) and Warner:

Webster R.L. 365 (C.I. 3780). Imported as Mongolian. Named Webster by the Minn. Agr. Exp. Station.

Iumillo R.L. 7. A selection from Iumillo made by Prof. W. Wiener of the Manitoba Agricultural College, Winnipeg, Man.

Kubanka R.L. 3. (Ott. 37). A pure line selection from Kubanka C.I. 1440.

Kubanka R.L. 125 (Sask. 45). A Saskatchewan selection. Sometimes known as Gharnovka.

Monad R.L. 205 (D-1). This variety was introduced in 1903, from Russia by Prof. H. L. Bolley of the North Dakota Agr. Exp. Station.

Pelissier (Peliss) R.L. 145 (Sask. 41). A Saskatchewan selection. The variety Pelissier was introduced from Algeria by W. T. Swingle of the U.S.D.A., in 1900.

Pentad R.L. 203 (D-5) was introduced from Russia, in 1903, by Prof. H. L. Bolley, of the North Dakota Agr. Exp. Station.

Discussion of Results

The reactions of the varieties as presented in the table are, in each case, the result of several consecutive tests. Sometimes the reaction of a variety to a physiologic form varied slightly in the different tests. Such variations often occur, and may be ascribed

to changes in environmental conditions, such as changes in light, temperature or humidity, to which both the plants and the rust organism are subject. When these variations occurred their range was included in the table, e.g., the reaction of Ceres to physiologic form 21 fluctuated from 3 to 4–. When, however, the reaction of a variety was reasonably constant it was indicated in the table by one figure only.

Two cases, Marquillo and Pentad, should be pointed out where the variations in reaction shown in the table are not due to environmental conditions. These variations, as explained in the foot-note to the table, are due to impurities in the varieties themselves, or at least in the samples used for this experiment. Iumillo also appeared impure though the percentage of impurity was smaller. Similar differences in rust reaction were observed in these varieties in the field and, in Marquillo, at least, morphologically similar plants showed marked differences in their reaction. Thus it is probable that these differences are of a genetic nature, especially since it is known that 1 to 3 per cent. of natural crossing occurs in wheat in the field. It should be noted that in the varieties in question, the bulk of the plants are resistant. Since it is naturally easier to detect such heterogeneity in resistant varieties than in susceptible ones, one may be led to suppose that more susceptible varieties may be similarly impure, though such impurities are more difficult to detect.

Apart from these observations the table is largely self-explanatory. Of the common wheats, McFadden's Emmer, Marquillo, Webster, the Sevier x Dicklow crosses, and the Marquis x Kanred cross, show the greatest degree of resistance. It will be noted, that according to the explanation of the types of infection, some of these varieties would fall into the moderately susceptible class. It should be pointed out that, although "3" is classed as a moderately susceptible, this division is somewhat arbitrary, and there is some question as to whether a variety giving a constant "3" reaction in the greenhouse might not be moderately resistant in the field.

The two Marquis x Kota crosses, Ceres and N.D. 1656, do not differ very markedly from Kota in their reactions, though they appear slightly more resistant to forms 29 and 32. The other new varieties, Garnet, Reward, Axminster, Warren, Quality and McKenzie's Selection appear rather susceptible in these tests. Of the durum wheats tested, Iumillo and Pentad are the most highly resistant, though as was remarked previously, both these varieties appear somewhat impure.

SUMMARY

1. Twenty-three common wheat varieties and crosses and six durum wheat varieties were tested for their reaction to seven physiologic forms of *Puccinia graminis tritici*, namely, forms 21, 29, 30, 32, 34, 36 and an apparently new form.

2. The following common wheats showed some resistance to most of these physiologic forms: Marquillo, MacFadden's Emmer, Marquis x Kanred (Minn. B-2-5), Sevier x Dicklow R.L. 368 (G. 149), and Webster. The Marquis x Kanred cross was immune to four of the seven physiologic forms, but susceptible to the remaining three.

3. Of the durum wheats Iumillo and Pentad were highly resistant.

4. Three varieties, Marquillo, Iumillo and Pentad, appeared genetically impure. The majority of the plants were resistant to most of the physiologic forms, but a number always appeared susceptible.

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Recommendations and Directions for the Control of Stored Product Insects Under Indoor Conditions.

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The control of insects attacking stored products, such as grain, nuts, dried fruits and products manufactured from them is a matter of interest to every householder and manufacturer, since all, at one time or another, become aware of the presence of pests in foodstuffs. Flour and grist mills and warehouses are not infrequently infested with large numbers of insects which do enormous damage while grain products in the household are frequently attacked by insects, although rarely to such a degree as to cause alarm. Nevertheless, enquiries relating to the control of these pests are received in considerable numbers and it seems advisable to make available at the present time such information as is available concerning their control.

Because control measures against most insects found indoors are essentially the same, the recommendations here made apply to almost all insects infesting buildings. In many cases much simpler recommendations may be made for certain insects and in most cases in the household the destruction of pests attacking foodstuffs is a simple matter and entails no cash outlay. For this reason recommendations for the control of insects in foodstuffs are treated separately, the general recommendations made applying to infestations of a more extensive nature, such as those in which a room or entire building is infested.

Control in Mills, Warehouses, etc.

The control of the pests may be obtained by: (1) superheating, (2) fumigation, (3) freezing. An important part of control measures is the preliminary clean-up. By removing all waste substances, dust, etc., and destroying by burning, many insects will be destroyed and penetration of poisonous gases and heat aided.

Superheating

The premises should be thoroughly cleaned before control operations are commenced, all loose material being disposed of. Finished products should be removed to a warehouse and not returned to the mill. It is necessary to maintain a temperature of 120 to 125 degrees Fahr. for at least twelve hours, and a period of eighteen to twenty hours will give even more satisfactory results, enabling the heat to reach into corners of the building and penetrate the grain, etc.

The amount of radiation surface will depend to a great extent upon the outside temperature. With an outside temperature of more than 80 degrees little difficulty should be experienced in bringing the mill temperature to the required level. Where the permanent heating system is not sufficient to produce the desired temperatures a temporary system may be installed by placing coils close to the floor and connecting them with a threshing machine or steam roller boiler.

Each floor should be closed off from the others in order to prevent the heat from ascending to the top floors. The temperature should be taken about a foot from the floor on each level, two or three thermometers being used in each case, or one will suffice provided it is placed in the coolest position on the floor treated.

Important Considerations in Heating of Mill, etc.

1. Steam pipes should be located near the floor in order to give an equal distribution of heat.
2. Provide water trap for drawing off accumulation of water in pipes.
3. Lower floors and floors with heavy machinery should have more radiating surface than upper floors and those with light machinery.
4. The most satisfactory pressure is between 30 and 50 pounds.
5. Beginning to heat immediately after closing down utilizes the heat in the machinery.
6. Stairways and elevator shafts should be closed.

7. The time is to be measured from the hour at which 118 degrees Fahr. is reached. Twelve to twenty hours at 120 degrees is necessary in order to secure penetration.
8. Do not attempt to heat on a cold, windy or rainy day. The outside temperature should be at least 75 degrees.
9. By commencing heating on Saturday and continuing until early Monday there will be no appreciable loss of time in operation.
10. Oil all machinery after heating.

Fumigation

In many cases it is not found convenient to superheat, and, while the results are not nearly as satisfactory, fumigation is preferred by some millers. The substances generally used are Hydrocyanic-acid gas and carbon bisulphide. In addition another cyanide preparation, calcium cyanide, has been recently tested and promises, because of the ease of application, to replace the more expensive and complicated Hydrocyanic acid gas method. Experiments conducted during the past season indicate not only that this substance is well adapted to fumigation on a large scale, but that the results are highly satisfactory. Moreover, the odour of the gas is distinctive, is more evident than in the old method and therefore less dangerous to use since its presence is always quite obvious when present in dangerous quantities. In fumigation it is essential that the building be thoroughly cleaned and the contents scattered as much as possible. The gases generally used are lighter than air and penetrate only a short distance into bags of grain, etc. Carbon bisulphide and carbon tetrachloride have greater penetrating powers than cyanide.

Fumigation with Hydrocyanic-acid Gas (Liquid Method)

Cyanide is the only substance as yet considered entirely suitable for fumigation of foodstuffs on a large scale. Other fumigants injure the foodstuffs more or less, are highly inflammable or are insufficiently tested to warrant recommendation.

It is necessary to fumigate twice as the eggs are but little affected by the treatment. The building should be thoroughly cleaned before commencing operations.

This gas is deadly poison when inhaled and the cyanide must be handled with care. Persons with cuts or sores should never handle cyanide: a small amount applied to the tongue may be fatal. Nevertheless, with careful handling there is no danger. The building must be thoroughly closed and as nearly airtight as possible and guards should be on hand to prevent anyone from entering the building. Every precaution must be taken: the workmen warned well in advance and rounds made to be certain that the building is vacant.

Material Needed

One four-gallon earthenware crock for each 6,400 cubic feet of space, and for each 100 cubic feet of air space:

1 ounce, by weight, of sodium cyanide.

$1\frac{1}{2}$ ounces, liquid measure, of sulphuric acid.

2 ounces, liquid measure, of water.

Method of Employment

A four-gallon crock will serve for four pounds of cyanide, 72 ounces of sulphuric acid and 96 ounces of water. Place the water in the crocks and allow the sulphuric acid to run slowly down the side of the crock, tipping it slightly. *Never pour the acid directly into the water.* The sodium cyanide is then measured into paper bags, each bag holding four pounds. (The bag must be large enough to leave plenty of space for tying and handling).

The crocks containing the diluted acid may be distributed with the required number on each floor, a bag of cyanide being placed beside each crock. Arrangements must be made to close off each floor, and elevator shafts should also be closed.

Commencing at the *top floor*, a man should move along each row of crocks, *commencing farthest from the exit.* On leaving the floor close the door (and lock if possible). Do each floor in succession, working from the top down.

Precautions

Arrangements must be made to open the doors or windows on each floor from the outside and no one should enter the building until these have been open for at least half an hour. No one should remain in the building while there is a noticeable odour of the gas. A very slight odour will be evident for a day or two, especially in the vicinity of grain bins, filled sacks, etc.

Never fumigate a floor until the one above has been finished; the same men should drop the bags of cyanide into the receptacles on all floors.

The temperature must be over 65 degrees Fahr. in order to give satisfactory results. An exposure to the gas of at least 24 and preferably 36 hours is necessary. The eggs are not killed. The process must be repeated within three weeks in order to destroy the larvae hatching from the unkilled eggs.

All arrangements must be in the hands of a thoroughly reliable man.

Satisfactory results cannot be obtained on a windy day, and unless the building is tightly sealed the gas may escape quickly and endanger the lives of nearby residents or workmen.

Treatment for Gas Poisoning

The treatment for poisoning due to inhalation of hydrocyanic acid gas consists of the immediate inhalation of ammonia or other alkaline fumes. Since ammonia is the most accessable and most easily handled it is advisable to have plenty of strong ammonia available when fumigation is being undertaken. Men carrying out the fumigation might each carry a bottle with them in case of emergency, especially when applying the gas in dust form.

Calcium Cyanide Fumigation

Fumigation with calcium cyanide differs only in method of application to that of the hydrocanic acid method. The preparation of the premises and all precautions are the same.

Calcium cyanide is secured in airtight containers in the form of a "dust" or powder. Upon exposure to the air the gas is given off. Coarse grade dust is recommended for fumigation of buildings.

Material Required and Application

The materials required for fumigation with calcium cyanide are as follows:

2 ½ to 3 lbs. of coarse grade dust per 1000 cu. ft. air space.

6 to 10 old newspapers per pound of dust.

Moisten about half the newspapers and distribute them about the building as when using crocks. Place tins of the cyanide on each floor, unopened. Spread a dry newspaper over each moist one in order to prevent the dust from coming in contact with the moisture. Equip each man (there should be only two or three, depending upon the numbers of rows of paper) with an instrument for opening the containers. The lids should be removed and placed lightly back in place. Commencing at the top floor, farthest from the exit, spread the dust on the papers, not more than ¼ inch thick, and close and lock the door; repeat on each floor, doing the lowest one last.

Fumigation may be commenced on Saturday and continued until early Monday morning. All precautions mentioned under the preceding method must be taken.

After 24 hours, provided the temperature is over 60 deg. Fahr. and there is sufficient humidity in the air, there should be little trace of gas, and this will disappear with a thorough airing. In order to render the residue entirely harmless, it may be placed in water and disposed of.

Care must be taken not to place the dust in actual contact with moist paper, since ammonia is then released instead of hydrocyanic acid gas.

Fumigation with Carbon Bisulphide

As has been previously pointed out, this gas has greater penetrating powers than cyanide and for this reason it is particularly useful for fumigation of grain, seed grain, etc. It is heavier than air and the fumes settle downwards.

Its great disadvantage is that it is highly inflammable and fire of every description must be kept away while there is a trace of the gas. It is said that even a spark from an electric switch will sometimes ignite it.

Application

Carbon bisulphide is employed at the rate of from 2 to 8 lbs. per thousand cubic feet of air space. The amount used depends upon the tightness of the room or receptacle. The liquid is poured into flat dishes and placed on top of the infested substances. Any liquid which remains after 24 hours may be saved.

Uses

The chief use of carbon bisulphide is for the fumigation of infested grains, etc., especially sacked goods and it may also be used to advantage in cases where an air-tight room has been provided for fumigation purposes, especially in a small outhouse where the temperature can be maintained at a suitable level without the use of a fire in the building.

Precautions

Carbon bisulphide cannot be safely used in a building in which there is a fire and

there must be no smoking while there is a trace of the gas. Notices should be posted warning against smoking in the vicinity of a building undergoing fumigation and no lanterns, etc., should be near the building.

While the gas is poisonous to animal life, there is no great danger from its use since the odour is most disagreeable and no one would be likely to enter a room containing gas.

Other Fumigants

Carbon tetrachloride has been used to replace carbon bisulphide as a fumigant. Its chief recommendation is that the fire hazard is not present. It has not been found satisfactory since the results obtained by using twice the quantity recommended for carbon bisulphide have given very much less satisfactory results and the substance costs at least twice as much per pound.

Freezing

All insects attacking grain, etc., may be killed by exposure to a temperature of 0 deg. F. for a few hours and a temperature of 10 deg. F. will destroy them in ten or twelve hours. Since the cold must be allowed time to penetrate the period must be increased and 24 to 36 hours is recommended. The usual preliminary clean-up is necessary.

Precautions

In the case of freezing the precautions differ from those where heat is employed.

All water pipes must be drained. All windows and doors should be fully opened. After freezing the building must be heated for several hours in order to warm the machinery. The oil in the machinery may be loosened by the use of coal oil and all the necessary parts re-oiled afterwards.

Cold Storage

The use of cold storage for the storage of grain products, nuts and dried fruit is recommended wherever possible. Insects will not develop at temperatures below 40 deg. F. and even at that temperature the most hardy may be destroyed, in all stages, in two months while most pests will be destroyed in about three weeks.

Control of Stored Product Insects in the Household

In the household where only small quantities are to be treated the simplest control is, in winter, to place the infested foodstuffs in a mouse or rat proof receptacle and expose them in a shed or even in the open. The pests will be frozen and killed. Where the temperature goes below zero, a single night should prove sufficient to kill any insects. It is, however, recommended that the foodstuffs be left in such a place for two or three days, especially if the temperature does not go below 20 deg. Fahr. While the receptacles are free of their contents they should be thoroughly cleaned and also placed outside in order to destroy any eggs which might be adhering to them.

During the summer, when pests are more liable to be in evidence the most satisfactory procedure is to place the foodstuffs in the oven for an hour or two at a temperature of 130 to 140 deg. Fahr. With small quantities of material the eggs and larvae will be quickly killed at this temperature. Flour so treated will be quite free from insects after sifting and none the worse for the infestation or heating.

General Observations

In mills and warehouses the damage due to pests may be greatly lessened by keeping the premises free from dust, etc. While this entails considerable work in a mill, its effect in keeping down pests will be found to be very noticeable since many insects feed very largely in small accumulations of grain materials.

The entire success of any control measures depends upon its thoroughness. In heating it is much better to continue the high temperature for several hours longer than recommended in order to secure satisfactory results than to use the minimum time recommended. In fumigating, the same applies, and a slight addition to the amount of substance recommended is much better than a strict adherence to the recommendations. It must be remembered that each building differs insofar as "tightness" is concerned and while good results may be obtained in one building with a given amount of fumigants, another building may require more or less of the fumigant employed. The essence of this is that each operator must do his own experimental work. The treatments recommended *will destroy the pests if properly employed*. Failure to secure control can be due only to faulty application, insufficiently tight building, the use of insufficient materials or too short an exposure.

Soils in Relation to Geology.

A General Discussion of the Origin, Nature and Known Requirements of Some Well-known Classes and Types.

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Soils consist of broken and weathered rock fragments and decaying organic matter, which combined and complex material covers the earth in a thin mantle and gives mechanical support and in part sustenance to plants. From this description, it is readily seen that soils are very intimately related to geology, derived as they have been, for the most part, from rocks of varying kinds and mineral values. During countless ages such rocks have been subjected, more or less, to each of the disintegrating agencies of water, ice, wind, temperature change, plants and animals, and to each of the decomposing influences exerted by various chemical processes, such an oxidation, deoxidation, carbonation, decarbonation, hydration, dehydration, and solution. While consideration in detail of these soil-forming factors sheds much light on the origin of soils, limited space inhibits such discussion here. There is but scope in an article such as this for the general treatment of various aspects of some well-known soil classes and types.

Glacial Soils (the Predominant Class)

In addressing oneself to the subject as above outlined, one is immediately confronted with the fact that whatever soils were originally formed from the prevailing bedrock of Canada and of north-central and north-eastern United States, were, many thousands of years ago, swept away by the vast Pleistocene ice sheets that enveloped the northern two-thirds of the continent. In consequence of this immense invasion, which consisted of two, if not five, distinct advances and recessions of the ice with their corresponding inter-glacial periods, the northern landscape was strewn with glacial drift or till of varying depth. The advancing ice—impelled in all directions by the tremendous pressure of accumulating snow, ultimately converted into ice, at three plateau centres in the north—ground the underlying rocks with irresistible force. The varied rock material, embedded in the ice, served to increase the rock-cutting and grinding power of this slow-moving mass, which in parts was fully 7000 feet in thickness. As these tremendous ice sheets melted back, the accumulated débris was of necessity left behind. When the retreat was rapid the deposit was thin and uniform, and glacial soils of this class are today the most important agriculturally, because of their level topography and wide extent. The soils of the Middle West are of this class. When a halt in the retreat occurred, the material was left in irregular hummocks. The area of this latter, fortunately, is relatively small. Streams flowing from the receding ice front were heavily laden with sediment, which was distributed, assortedly, far and wide in regions far removed from the retreating glacier. But the material thus laid down was soil material, not soil. Considerable weathering, involving physical and complex chemical actions, and the intervention of plants and animals, especially the former, were necessary before a true soil could be formed. These soil-forming processes are indeed still going on apace, for glacial soils are still in their youth. The varied nature of the rock material, frequently transported hundreds of miles from their northern source, from which they were formed, also renders them soils of much variation and of great potential possibilities. Thus the ice invasion of the so-called Ice Age caused a more or less masking of the prevailing rocks and of the original topography of northern North America. But this tremendous "accident of Nature" has had a far-reaching effect upon the development of agriculture and industry in these northern lands, as witness the large populations they carry, or could carry, today. It has meant that, among other important effects, the soils of the northern two thirds of the continent have been rejuvenated, as the

result of new and varied soil-forming material taking the place of old worn residual soils.

Glacial soils, which occupy the surface of practically the whole of Canada and of some half million square miles of the United States, are, according to various authorities on soils including Lyon and Buckman, (1) usually heavy soils—mostly loams, silt loams and clay loams. Their subsoils, consisting of finer particles than do their surface soils, as a rule, frequently promote poor drainage. Thus, on the whole, these soils respond very much to systematic draining. Being young soils, their component particles are individually less weathered than are those of residual soils (old soils). As a class, their colors are usually grays or browns, though red may prevail where they have been formed from ground-up red sandstones or as the result of an admixture of old residual soil in which iron was much in evidence. Their subsoils, which are light gray to brown, are often mottled—due to lack of aeration. In chemical composition they resemble to a greater degree the rocks from which they were formed than do residual soils the rocks of which they are residues. The much longer period of weathering and leaching in the latter case explains this difference. Thus the content of mineral elements in glacial soils is governed to a considerable extent by the composition of the original rock. Calcium—so essential to a fertile soil—for example, depends very largely upon such a relationship between glacial soil and parent rock. Glacial soils derived from poor shales low in calcium are markedly deficient in this element. The poor Volusia upland soils of New York and Ohio are of this class. Limestones giving rise to glacial soils will, as a rule, cause a high content of calcium to be found therein, as is the case with the productive Ontario loam (brown) of Central New York, which soil originated from calcareous till. Residual soils derived from limestones, on the other hand, will usually be found to be low in calcium, for in their case greater weathering has occurred and consequently greater leaching out of the calcium, in readily soluble forms, over a longer period of time, as was shown by Chamberlain and Salisbury (2) on comparing soils from driftless and glaciated limestone areas, respectively. The climatic conditions that have existed since the glacial material was laid down, also, have very largely determined the organic matter

Glacial drift or till, over Limestone, inside a morainic loop—giving rise to heavy soils. View represents a highly developed stock farm, 5 miles south of Columbus, Ohio. (Photo by G. J. Callister).

COMPOSITION OF VARIOUS EXTENSIVE TYPE SOILS OF THE UNITED STATES:
Pounds in 2 million of surface soil ($6^2/_3$ inches deep.)

Locality	Soil Formation	Soil Type	P	K	Ca.
Illinois	Glaciated (Average of 4)	Grey & Brown Silt Loams	1100	31,592	15,235
Illinois	Unglaciated	Yellow Silt Loam	950	31,450	5,340
Ohio	Glaciated	Volusia—silt loam (upland, from poor shales.)	1480	38,300	4,850
Connecticut	Glaciated	Fine sandy loam (valley land.)	1920	22,500	33,430
Missouri, Wisconsin & Illinois	Glaciated (Loessial) (Average of 3)	Silt loam (prairie)	1806	32,633	9,526
N. Carolina	Piedmont (Residual)	Cecil Clay	950	22,700	2,000
Maryland	Granite & Gneiss (Residual)	Chester Mica Loam (Upland)	1130	34,400	3,290

content of these soils. Where the moisture conditions, particularly, were favourable for luxuriant plant growth, the surface soils are dark in colour—indicative of a content of much organic matter. Conversely, where the climate was unfavourable to the growth of abundant vegetation, the soils lack that more or less black colour that bespeaks the presence of plenteous organic residues. Available calcium and other mineral nutrients in adequate supply are also favourable to luxuriant plant growth. Hence their presence in weathering glacial drift, together with favourable climatic conditions, would eventually ensure the occurrence of abundant organic matter in glacial soils. The black prairie soils of Western Canada reflect the existence of these favourable conditions during their making. Glacial soils, however, comprise a great many types, differing not only physically but also in fertility—in accordance with the chemical composition of the parent rocks and to some extent with post-glacial climatic conditions. The above table, compiled from data published by the late Dr. C. G. Hopkins (3) of Illinois, gives some idea of the primary essential mineral values of glacial soils in comparison with those of other classes.

Note the high content of calcium in the Connecticut valley soil, which high content doubtless resulted partly from the leaching or washing of calcium from the adjoining uplands. The low content of calcium in the residual soils, likewise, reflects the leaching of this essential element that has taken place during the weathering (in situ) of the parent rock.

Other tables, shown hereunder, also compare the chemical value of glacial clay and glacial prairie soils, as classes, with those of residual clay and glacial lake prairie soils, respectively.

As to the general requirements of glacial soils, these include drainage, where needed; farm manure liberally supplied on the lighter-coloured soils; and lime and phosphates, where calcium and phosphorus are shown by analysis and by plant growth to be deficient. Potash is required only on sandy and gravelly soils, as a rule.

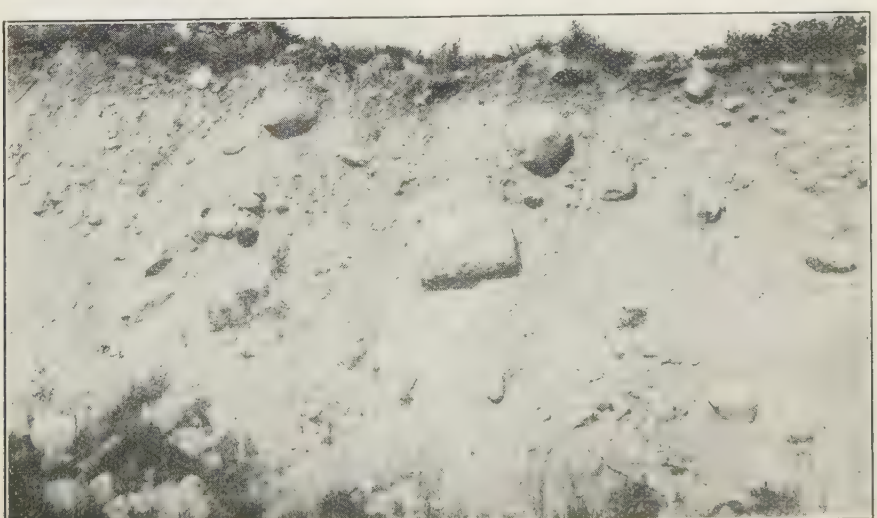
Glacial Lake Soils

Here and there across the continent, forming as a rule the lowland soils of most regions, are to be found soils which originated from deposits in temporary glacial lakes that in turn came into existence as the result of ice-fed waters having been ponded between the ice front (which stood at certain points during the advance or retreat of the glacier) on the north and heights of land on the south. Streams running from off and out of the ice and over glacial deposit, particularly along the ice front, laid down in these ponded waters material of various kinds—ranging from coarse delta material, including gravels, along shore, to fine silts and clay in deep and comparatively still water. The draining of these lakes (some of which were of vast extent) as the result of adequate recession of the ice, left behind sediment of varying texture and depth that was destined to form some of the most fertile soils on the continent, if not in the world. Among these we have the celebrated wide expanse of level

fertile Red River Valley soils of Manitoba and North Dakota that formed the bed of huge Glacial Lake Agassiz; the lowland soils of Utah, once the bottom of immense Glacial Lake Bonneville; Nevada valley soils, deposited in Glacial Lake Lahontan; the Dunkirk clay soils of New York and Ohio, the lower Niagara Peninsula soils, the soils along the northern shores of Lakes Ontario and Erie, all of which were deposited in the shallow border waters of Glacial Lakes Iroquois and Warren. The Clay Belt soils of Northern Ontario and Quebec have a similar origin. There might also be included here the soils of the St. Lawrence and Ottawa Valleys, which soils were deposited in the Champlain Sea which existed immediately following the melting back of the ice from athwart the Gulf of St. Lawrence at the close of the Glacial Period. Into these intruding sea waters was deposited sand, silt and clay from out the melting ice and from the adjoining moraines of unconsolidated till. As these deposits were taking place, and subsequent thereto, the northeastern portion of the continent had been rising (some geologists claim the rise is still proceeding slowly), and in consequence of this uplift the St. Lawrence lowland was eventually left high and dry. This accounts for the presence throughout this area of Leda clay and Saxicava sand, which sediments covered the earlier-deposited till sheets and, upon weathering and the incorporation of plant residues, gave rise to the clays, clay loams, loams and sandy loams that we find in this region today.

Like Glacial soils, these glacial lake soils resemble in chemical composition the material from which they were formed, this resemblance being particularly true with respect to calcium. Consequently they vary chemically in accordance with the variation that exists between the glacial materials from which they are the wash. In colour they vary from gray to black depending upon the organic matter present. Where the conditions have been specially favourable for luxuriant plant growth since they were "left high and dry", organic residues in abundance have become incorporated with them, giving them their more or less black colour and contributing liberally to their fertility. This is particularly the case with the soils of the Red River Valley, Manitoba. On the whole, the finest-textured of these Glacial Lake soils respond well to drainage operations (the chief requirement), where the grade is adequate, as do their related heavy glacial soils. Where the texture and topography provide for natural drainage or where systematic artificial drainage has been provided, they are particularly fertile soils — noted for their abundant crops of cereal grains and hay, and, where market conditions are favourable, for their fruit and truck crops.

The following results of analysis, made by Dr. F. T. Shutt (4), Ottawa, show in a gen-



Section showing soil developed on glacial boulder clay, drift or till; Lake Simcoe District, Ontario. (Photo by Canada Geol. Survey).

COMPOSITION OF WESTERN CANADIAN SURFACE SOILS
Pounds per Acre in 2 million of soil (about 6 $^2/_3$ inches).

No. of Samples Analysed	Canadian Province	Total Nitrogen	Acid—soluble. Phosphorus	Potassium	Calcium
1.	Manitoba (Red River Prairie)	20,100	2530	17,100	27,000
6.	Northwest Territory (Saskatchewan & Alberta)	9,180	1520	5,670	4,130

eral way a comparison between the chemical values of virgin prairie glacial lake soils as found in Manitoba and those of virgin prairie glacial lake soils as found in Mani-prairie glacial soils as represented by samples taken in the Northwest Territory (Saskatchewan and Alberta). (See table above.)

Loess Soils

A class of very fertile soils, whose origin to some extent has been dependent upon glaciation, is the loess soils—found in the basin of the Mississippi and its tributaries, in the valleys of the upper Rhine and its tributaries, in South Russia, in Roumania and neighbouring countries to the north, and in China. In these regions they were laid down mainly, it is believed, by wind action. Immediately after the ice disappeared from North America and North Western Europe there lay around immense quantities of rock flour—the result of glacial grinding. At this time there set in a prolonged period of aridity and of strong westerly winds. The latter lifted the finer portion of this rock flour as dust particles, carrying it continuously in an easterly direction until it eventually came to rest around grasses growing on the plains or in the valleys. Periodic floods are thought also to have assisted in the distribution of these deposits. Under these conditions there accumulated appreciable areas of this fine-textured material which has since consolidated somewhat and weathered into its present highly fertile condition, augmented of course to some extent by the plant residues of centuries. The mineral content of these loess soils is high, for they had their origin in various kinds of rocks. The fine texture, the open structure, and the adequate mineral sup-

A Scene on Glacial Lake soil at Morden, Manitoba, Experimental Farm. (Extensive level area of very fertile soil, once part of the bottom of vast Glacial Lake Agassiz).

ply of these calcareous silt and clay loam soils make them, where adequate moisture exists, extremely fertile soils. They indeed rank as one of the world's most noted classes of fertile soils. They constitute the famous corn soils of Iowa and of other parts of the upper Mississippi region, and doubtless extend somewhat into the southern borderland of the Canadian Northwest. The following figures, averaged from data supplied by Clarke, (5) show the average chemical analysis of four loess soils in the States of Illinois, Iowa, Missouri and Mississippi:

SiO_2	68.11%
Al_2O_3	10.72
Fe_2O_3	3.00
FeO	0.565
MnO	0.06
P_2O_5	0.127
MgO	2.62
CaO	4.41
Na_2O	1.40
K_2O	1.775
H_2O	2.09
TiO_2	0.445
CO_2	4.2
C, organic	0.13
SO_3	0.20
Cl.	0.05

The table, shown elsewhere, compiled from data published by Hopkins, shows the primary essential mineral value of loess soils in comparison with those of glacial and residual soils, respectively. In this respect they show superiority to residual and unglaciated soils, in phosphorous to all but the glaciated valley soils, and in calcium to the poorer glacial soils. After producing crops for a number of years, their only requirements seem to be calcium and phosphorus, which should be supplied periodically.

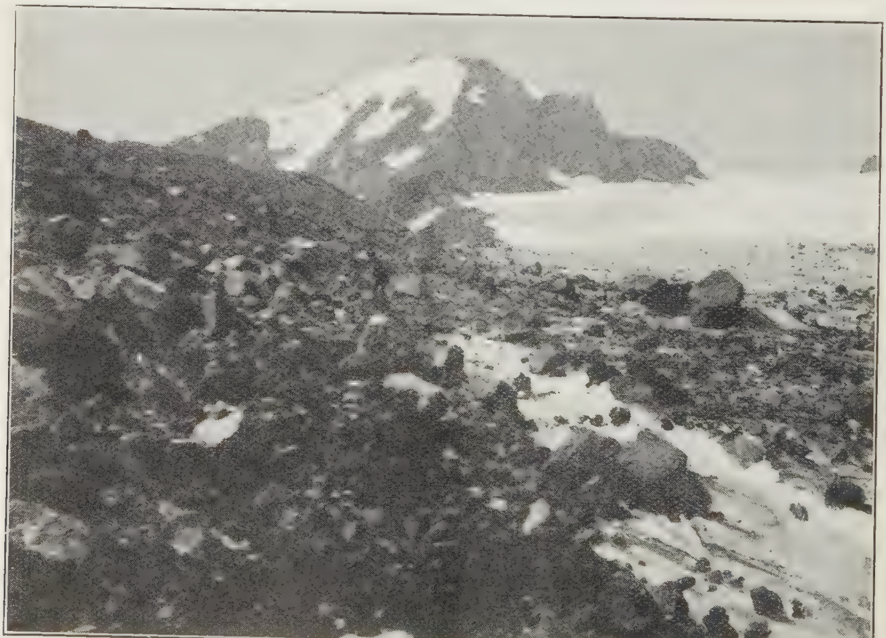
Soil Types Derived from Best-Known Country Rocks, with Data Available Respecting their Chemical Composition

In the case of residual soils, formed in situ from the underlying rocks, (ordinarily not found as such in Canada, except perhaps in a few very limited unglaciated areas, mainly on Gaspe Peninsula) we find the types mentioned below. Where the parent rock carried considerable quartz and a low percentage of clay-producing minerals (feldspar, hornblende and augite principally) sands and sandy loams prevail. Granites, gneisses and limestones usually give rise to more or less clayey soils, but loams may result where the limestone was sandy and the igneous rocks carried much quartz. Where potash feldspar (orthoclase) granite is the parent rock, an adequate supply of potassium for plant growth can be

Section showing transition from solid rock to soil; Lake Simcoe District, Ontario. (Residual soils such as this are forming, particularly from the softer rocks such as certain limestones, in isolated cases; but soils thus formed in situ from bedrock are not common in Canada.) (Photo by Canada Geol. Survey).

expected, also a fair supply of phosphorus derived from the minute crystals of apatite that are said to be distributed throughout this rock. On the other hand, unless the granite contains hornblende, the resulting soil will be deficient in lime, for neither lime nor calcite are usually found in association with this form of granite. As a class, gneisses weather more slowly than granites and, upon disintegration, yield more siliceous soils that are not as strong as granite soils (clays). Residual soils derived from the readily-decomposable vesicular or soft limestones are usually rich soils, due mainly to their adequate supply of available calcium. Such soils, when located in regions of plenteous rainfall, invariably are clothed with abundant vegetation which promotes deep-seated decay of the rock and the incorporation with the surface soils of abundant organic residues. Such conditions give rise to the saying "A limestone country is a rich country". Where the limestone is hard, however, there is slower disintegration and weathering, and consequently thinner soils result. Where the limestone is cherty, also, stony soils may exist. Notable examples of limestone residual soils on this continent are the soils of Central Kentucky (Bluegrass Region) and Tennessee, and other black prairie soils of the states to the south thereof.

Dolomites, or magnesian limestones, weather more slowly than limestone, thus giving rise often to gravelly and stony soil types. Sandstone weathers into sandy soils, though an argillaceous (clayey) sandstone may give rise to a rather heavy soil. Calcareous sandstone as a rule produces good soils—better type sandy loams with adequate lime therein, and often potash (from glauconite) and organic matter in goodly quantities. Quartzites and slates generally produce shallow soils, unfavourable in texture and fertility for crop growth. The basic igneous rocks diorite and basalt give rise to sticky reddish or yellowish clays containing little quartz. The latter soils, however, are usually very fertile soils, where climatic conditions are favourable. In general, they contain adequate supplies of potassium, calcium and phosphorus, the last being derived mainly from the minute needles of apatite which the parent rocks contained. Famous among such soils are the fertile Snake River and Columbia River soils of Idaho, N.E. California, Oregon and Washington; the Darling Downs soils of Southern Queensland, Australia; the Deccan soils of



Recently Abandoned Moraine, Hayden Glacier, Oregon. (This view compared with accompanying view of Farming Area, on Moraine, Golden Lake, Ontario, gives some idea of change that had to take place before soil fit for agriculture could result.) (Photo by U.S. Geol. Survey).

India; and certain soils in Rhodesia. Rocks carrying much mica (very slowly decomposable), such as the mica schists, yield highly micaceous soils, which, when once adequately decomposed, supply much potash to plants. The noted fruit and alfalfa soils of Central Otago, southern New Zealand are of this class. Serpentine rock usually gives rise to poor barren soils, due mainly to the leaching out of the soluble magnesium and other alkalies and leaving behind material largely made up of silica, alumina and iron. These soils are described as "the barrens" in the United States.

But what of glaciated soil types derived from the familiar country rocks? As was indicated above, these soils, though pulverized by ice action, have been subjected to far less weathering and leaching than were the old residual soils. Consequently they contain, as a rule, more of the essential minerals than do the latter. In an endeavour to illustrate this difference, comparative figures, averaged from data supplied by Clarke, (6) are submitted below. The residual clays are presumably situated in the Driftless Area of the upper Mississippi region .

"A" *Residual Clays*—(average of 4 Wisconsin soils).

"B" *Glacial Clays*—(average of 2 soils from Milwaukie, Wis.)

	"A"	"B"
$Si\ 0_2$	55.73%	44.51%
Al_20_2	18.16	8.0
Fe_20_3	10.57	2.68
Fe 0	0.63	0.565
Mg 0	1.115	7.425
Ca 0	0.99	13.74
Na_20	1.44	0.88
H_20	9.4	1.985
$Ti\ 0_3$	0.255	0.40
P_20_5	0.03	0.09
Mn 0	0.035	0.015
$C0_2$	0.35	17.11
Organic C	0.46	0.35
$S0_3$		0.09
Cl.		0.05

The higher contents of magnesia, lime, potash and phosphoric acid in the glacial clays should be specially noted.

Emerson (7) has shown diagramatically the relationship that sometimes exists between glacial soils and their underlying rocks. Where the glacial movement has been across granites, sandstones, dolomite, and limestone, in the order named, and where apparently the till is relatively thin, he indicates that stony loams superimpose the granites; sandy loams the sandstone; sandy and silty loams the dolomite; and loam, silt loams and calcareous subsoil the limestone formation. These being glacial soils, the hard granity stones

Farming area on soil derived from glacial moraine; Golden Lake, Ontario. (Photo by Canada Geol. Survey).

in the soils over granite have not yet had time to weather into clay; and, similarly, in the case of the loamy soils overlying the limestone the post-glacial weathering processes have been insufficient to deplete these soils of the major portion of their soluble minerals, which they have inherited partly from the limestone beneath and partly from other rock formations located at points to the north. Such admixtures of varying rock materials, in glaciated regions, assuredly have made for rejuvenation of soils, which in turn has had a profound effect upon agriculture as practised by the succeeding civilization.

CONCLUSION

In conclusion of this necessarily restricted article, it need but be stated that it is obvious that soils are for the most part the product of the incessant changes of various kinds to which rocks of varying types have been subjected. Such soils themselves, however, are ever changing—by physical, chemical and biological agencies and processes—in consequence of their incessant efforts to gain equilibrium; and the existing qualities of these soils have been determined by the values of the parent rocks and by the nature and extent of the changes that such have undergone during reduction and that have intervened since the deposition of the disintegrated and weathered soil-forming rock materials. Indeed, rock-formation itself has resulted from the operation of this universal law of Nature —the law of change.

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(5) Clarke, F.W.—"The Data of Geochemistry", Bulletin 695— United States Geol. Survey, 1920—page 506.

(6) Ibid., page 503.

(7) Emerson, H.L.—author of "Agricultural Geology", New York, John Wiley & Sons, Inc., 1920. (Diagram reproduced by Lyon and Buckman on page 56 of their above-mentioned publication.)

Book Review

An Introduction to the Marketing of Farm Products, by Dr. Alva H. Benton. (A. W. Shaw Company, New York and Chicago, $5.00.)

This book, by the Head of the Department of Marketing and Rural Organization at the North Dakota Agricultural College, is one of the more comprehensive among the recent texts on marketing. It is largely descriptive of the methods employed in the marketing of all of the more important and some of the less important farm products. In the main it is interesting reading. Fair consideration is given to both private and coöperative marketing. In addition to descriptive material, one chapter is devoted to each of the following,—"The Origin and Development of Our Marketing Systems", "Marketing Services", "Purchasing Farm Supplies", "Marketing Legislation". Two chapters are devoted to coöperative marketing. A list of references is given at the end of each chapter.

The lists "Self Test Questions" at the ends of the chapters are very suggestive and add much to the value of the book.

—F. M. Clement.

The Longevity of Legume Bacteria on Inoculated Alfalfa Seed.*

A. G. LOCHHEAD

Dominion Agricultural Bacteriologist, Central Experimental Farm, Ottawa

Under practical conditions of legume seed inoculation with cultures of the nodule organism (*B. radicicola*), it is usually recommended that the seed be inoculated immediately before planting if the best results are to be obtained. There is, however, considerable evidence that *B. radicicola* is able to live for comparatively long periods of time outside the host plant, and exhibits resistance to a considerable degree against such adverse agencies as cold and desiccation.

Pure cultures of *B. radicicola* are capable of retaining their ability to produce nodules for a long period of years. Edwards (3) reports having secured good nodule production with a culture from red clover 16 years old, with one from white clover 10 years old, and an alfalfa culture 10 years old, during which times subcultures had been made but twice in each case.

In soil, the nodule organism is able to remain active for years, though its longevity appears to be greater under natural conditions than in samples of dried soil removed from the field. Albrecht (1) found soybean and red clover bacteria alive in field soil and capable of producing nodules profusely six and a half years after removal of the crop, although in the case of dried soil samples their nodule-producing ability was found to decrease noticeably, so that after 6 years it was completely lost. Soil acidity was found by Richmond (6) to be an important factor in affecting the longevity of the nodule organism in the soil. Both soybean and cowpea organisms were found to survive three years' storage in soils having a lime requirement of one ton or less, while in soils with a 6000-lb. lime requirement they were killed after the same period of storage.

Respecting the longevity of *B. radicicola* on the seed itself, with which subject the present paper is particularly concerned, the exact information available is limited. The question of the viability of nodule bacteria on seed has a certain practical bearing. Seed inoculation by seed dealers themselves would have obvious advantages over the present method, whereby the farmer inoculates his own portion of seed before sowing, provided such inoculated seed retained sufficient numbers of active organisms capable of inducing satisfactory nodule formation when grown after a period of storage. More uniform and more economical inoculation would be possible, while legumes could be more successfully grown in cases where farmers, for one reason or another, are unable to secure cultures for inoculating.

Fellers (4) found soybean and alfalfa seed, inoculated with a nodule infusion, to retain viable organisms on their seedcoats 6 to 9 months. Commercial cultures of *B. radicicola* were also found to give as good results as inoculation with nodule infusion. This author, testing a variety of methods of applying the inoculum, finds such substances as gum tragacanth of little aid in keeping bacteria alive on the seed. As a result of his tests, the author concludes that ordinarily a delay of several days, or even a month before planting should work no practical harm. Testing likewise the effect of methods of inoculating on the viability of the organisms on the seed, Alicante (2) states that some legume organisms remain alive after 60 days' storage. The addition of sugar to the bacterial infusion used to inoculate was found to be beneficial, although adding soil or glue did not show any advantages. Legumes tested included soybeans, sweet clover, garden peas and cowpeas. The author concludes that the time of storage, up to two months, does not materially influence nodule production. Richmond (6), in the paper previously referred to, states that soybean seeds, inoculated by muddy water from a neutral soil, retained viable organisms on their coats for almost one year, though similarly treated seeds,

* Contribution from the Division of Bacteriology, Central Experimental Farm, Ottawa.

The writer is indebted to Dr. G. P. McRostie, Dominion Agrostologist, for helpful advice in connection with the planning of the experiments described in this paper.

using an acid soil, were free of nodule bacteria within 7 days. Furthermore, Hansen (5) in discussing the longevity of nodule bacteria on seed, states that seed should be inoculated at the time of seeding, and that the method used by some seedsmen of selling inoculated seed is not sound as far as effective inoculation is concerned. No experimental data on this point are given.

Experimental

For the purpose of studying the longevity of *B. radicicola* on inoculated alfalfa seed, experiments were commenced in 1925 and repeated and extended in 1926. Contrary to the practice followed by previous authors (2, 4) the seed was not sterilized before being inoculated, the object being to approximate more nearly ordinary warehouse conditions. Many legume seeds undoubtedly carry viable nodule organisms capable of inducing nodule formation. This source of error, however, may be avoided by the use of uninoculated checks, so that the actual effect of the inoculation may be judged.

In Experiment 1 (1925) and Experiment 2 (1926) which comprised the main tests, 24-oz. or 16-oz. quantities of alfalfa seed were inoculated at intervals of time with a 12 to 14 day old "nitro-culture", similar to those prepared by the Dominion Experimental Farms, for distribution to farmers. These are agar cultures, slanted in 2-oz. "Blake" bottles, the medium having the following composition:—dipotassium phosphate 0.2 gm., magnesium sulphate 0.2 gm., sodium chloride 0.2 gm., calcium sulphate 0.1 gm., calcium carbonate 1.5 gm., saccharose 17.5 gm., mannite 2.5 gm., agar 15 gm. and water 1000 cc. Inoculation was made in the proportion of 1 bottle "nitro-culture" to 1 bushel seed, the "skim-milk" method of applying the culture being used, in which the bacterial growth is suspended in sweetened skim-milk, poured over the seed and well mixed. For 60 lb. seed 20 oz. skim-milk and 4 tablespoons sugar are used. These proportions were kept throughout, the amount of liquid being just sufficient to moisten the seed without unduly wetting it. After thorough mixing by hand, the seed was allowed to dry in a thin layer and then bagged in 8 oz. lots. One sample was kept at room temperature, and another stored in a refrigerator, the temperature of which averaged 3° to 5°C. In Experiment 1, a few samples, prepared during the winter months, were stored in the loft of a barn, subject to the influence of fluctuating outside temperatures.

In addition to the "skim-milk" method, a second method of inoculation was used in Experiment 1, in which fine sand was inoculated with a suspension of the culture, a tablespoonful of the inoculated sand being mixed with an 8 oz. bag of seed. The "skim-milk" method having been found to be superior in Experiment 1, it was used exclusively for later tests.

Planting of seed from all samples was done on the same date, seed being placed in sterile sand contained in ordinary glass tublers which were kept in a greenhouse. From time to time plant nutrients without nitrogen were added while uniformly suitable moisture conditions were maintained. After 5 weeks, nodules were counted.

Experiment 1. (1925)

Inoculations were made Jan. 29 and at intervals thereafter, usually 3 weeks, until June 20, at which date seeds were planted. Table 1 shows the results of the enumeration of nodules, summarized according to method of inoculation, storage temperatures and length of storage.

The results indicate a distinct advantage of the "skim-milk" over the "sand" method of inoculation, due largely, no doubt, to a more uniform distribution of the bacteria. With the "sand" method it was found that many plants were entirely without nodules, indicating that a considerable portion of the seed, though apparently well mixed, had failed to come in contact with the bacteria. Data on the other points tested are not so conclusive. The figures referring to effect of storage temperature are based on but 4 inoculation dates during the cold weather when samples were stored in the barn. There is some indication that the alternate freezing and thawing under this method of storage is unfavorable, while the rather moist, even cold of the refrigerator tends to act favorably. Regarding the effect of time of storage, it appears that viable organisms are to be found on inoculated seed after 20 weeks, although the highest nodule numbers were to be found on seed inoculated just before planting.

TABLE 1.

Alfalfa tests, 1925. Nodule formation under different inoculation and storage conditions.

Subject of Test	Conditions	Total number of plants	Total number of nodules	Nodules per plant
1. Method of inoculation.	Skim-milk method	153	1819	11.9
	Sand method	160	570	3.6
2. Effect of Storage Temperature (skim-milk inoculation)	Room temperature	33	386	11.7
	Refrigerator (3°-5°C)	35	575	16.4
	Barn	37	268	7.2
3. Time of Storage (skim-milk inoculation, room and refrigerator)	Planted immediately	9	257	28.5
	Stored 2 weeks	13	206	15.8
	" 5 "	20	122	6.1
	" 8 "	17	157	9.1
	" 11 "	16	275	17.2
	" 14 "	15	262	17.5
	" 17 "	17	155	9.1
	" 20 "	18	274	15.2
	Not inoculated	19	2	0.1

TABLE 2.

Alfalfa tests, 1926. Nodule formation under different inoculation and storage conditions.

Time of Storage	Room Temperature			Refrigerator (3° -5° C)		
	Total plants	Total nodules	Nodules per plant	Total plants	Total nodules	Nodules per plant
Planted immediately	21	795	37.9			
Stored 1 week	17	352	20.6	16	436	27.2
" 3 weeks	18	439	24.4	17	285	17.0
" 6 "	19	103	5.4	17	518	30.4
" 9½ "	22	142	6.5	23	566	24.3
" 13 "	20	171	8.5	23	480	20.8
" 17 "	20	171	8.5	11	178	16.1
" 20 "	19	4	0.2	17	487	28.6
" 23 "	15	163	10.8	12	410	34.1
" 26 "	21	130	6.2	15	255	17.0
Not inoculated	18	55	3.0	19	29	1.5
All stored inoculated samples	171	1675	9.8	151	3615	23.9

Experiment 2. (1926)

To secure additional data, particularly as to the effect of time of storage, repeated tests were made the following year in the course of which the number of seeds planted from each sample was increased from 10 to 25. Inoculations, by the "skim-milk" method, were made Dec. 22, 1925 and at intervals thereafter until June 23, 1926, storage of samples being made at room temperature and in a refrigerator (3° to 5° C.). The results of the examination of the plants for nodules are shown in Table 2.

As before, storage in the refrigerator appeared to favor nodule production, in this case much more noticeably than in Experiment 1. It may be noted, however, that the number of seeds germinating was lower than when storage was at room temperature. Although in none of the stored samples was the

nodule formation as great as with freshly inoculated seed, yet even after 6 months' storage, especially at low temperature fair nodule development may result from inoculation. We are unable to explain the failure of the 20-week sample at room temperature to produce nodules, particularly when simultaneously treated seed stored at low temperature gave high figures.

In Table 3 and Fig. 1 are shown the effect of time of storage, results being summarized for all samples.

There would appear to be a rather rapid falling off in nodule forming capacity after one week's storage, the decrease being less pronounced after this period. Although the number of nodules per plant as well as the percentage of plants showing nodules is greater with freshly inoculated seed, yet after 26 weeks the effect of inoculation is still apparent.

Experiment 3. (1926)

Since the previous experiment pointed to a noticeable decrease in nodule-forming

TABLE 3

Alfalfa tests, 1926. Nodule formation after different periods of storage. Summary of all samples.

Time of Storage	Total plants	Plants with nodules	% Plants with nodules	Total nodules	Nodules per plant
Planted immediately	21	21	100.0	798	37.9
Stored 1 week	33	33	100.0	788	23.9
" 3 weeks	35	35	100.0	724	20.7
" 6 "	36	32	88.9	621	17.3
" 9½ "	45	38	84.4	708	15.7
" 13 "	43	40	93.0	651	15.1
" 17 '	31	24	77.4	349	11.3
" 20 "	36	20	62.5	491	13.6
" 23 "	27	22	81.4	573	21.2
" 26 "	36	29	80.6	385	10.7
Not inoculated	37	8	21.6	84	2.3

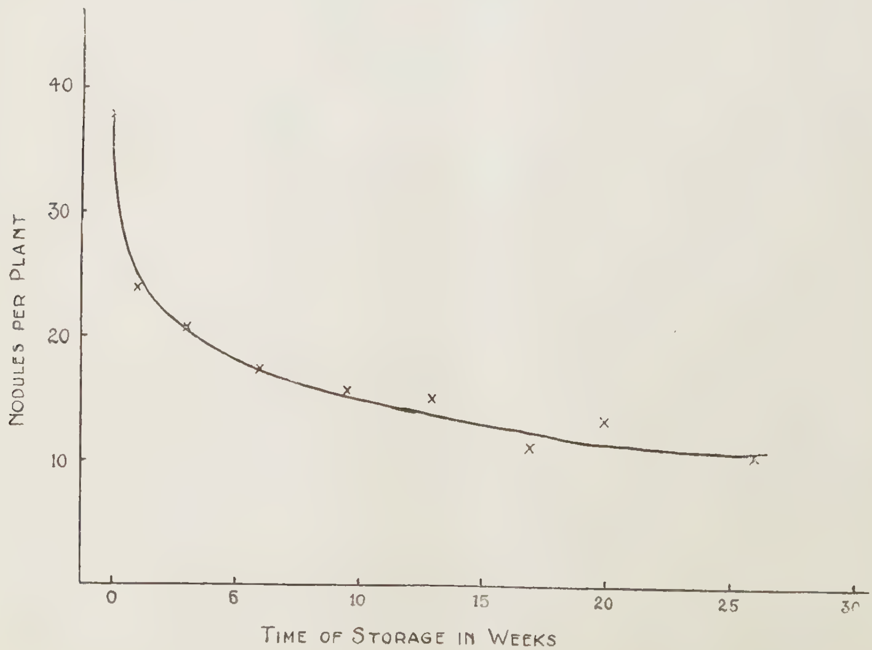

Fig. 1.—Nodule formation on alfalfa plants, seeds planted after different periods of storage. Average of all samples, 1926.

TABLE 4.

Alfalfa tests, 1926. Nodule formation and viable bacteria during first week after inoculation.

Time of Storage (Room temperature)	Total plants	Plants with nodules	% Plants with nodules	Total nodules	nodules per plant	Colonies of B. radicicola from 100 seeds
Planted immediately	35	35	100.0	351	10.0	77,000
Stored 1 day	30	26	86.7	201	6.7	12,100
" 2 days	34	32	94.1	195	5.7	plates spoiled
" 3 "	39	27	69.2	118	3.0	1,700
" 4 "	27	16	59.3	68	2.5	6,400
" 5 "	35	18	51.4	75	2.2	8,200
" 6 "	24	13	54.2	66	2.7	3,400
" 7 "	32	20	62.5	127	4.0	3,300
Not inoculated	42	4	9.5	17	0.4	1,200

capacity during the first week of storage, a further test was made in order to study more closely the changes occurring during this first week after inoculation. A quantity of seed was inoculated as usual, and samples removed immediately for planting and every 24 hours thereafter for 7 days. In addition to the planting tests, estimations were made of the numbers of viable nodule organisms adhering to the seedcoats by plating on modified Ashby's agar, as previously described, suitable dilutions made by shaking 100 seeds in 100 cc. sterile water. Plates were examined after 12 days at room temperature. For this, as for the other experiments, the seed was not sterilized prior to inoculation. Consequently colonies of organisms other than *B. radicicola* appeared on the plates, rather few in number, however, compared with the nodule bacteria, colonies of which latter could be estimated with reasonable certainty. The results are shown in Table 4.

In this test, made in September, growing conditions were less favorable than in the preceding experiments. Tumblers were kept in the greenhouse, which, however, was not heated at the time, and to this is to be ascribed the smaller size of the plants after 5 weeks and also the smaller average nodule numbers. There seems evidence, however, of a falling off in nodule-forming power after even 24 hours' storage, which is accompanied by an even sharper decline in the numbers of viable organisms remaining on the seedcoats. As was noted by Fellers (4), the number of bacteria per seed did not correlate very closely with the number of nodules per plant. It is probable, as this author suggests, that the cells of lower root infecting power are the first to die off. In any case the numbers of bacteria on inoculated seed appear to decrease more rapidly than their nodule forming capacity. There would, indeed, appear to be room for increasing the effectiveness of our "nitro-cultures" through a study of factors affecting the root-infecting power of the legume organism.

It should be borne in mind that the above data are not necessarily applicable to the field, or that a decrease in nodule-forming capacity in glass tumblers implies of necessity a corresponding decreased yield under field conditions. As Wilson (7) points out, it has not been established that maximum nodule numbers are necessary for maximum crop yield. Although it is assumed that greater nodulation means greater yield, yet it is conceivable that lessened nodule forming capacity (as affected by storage, etc.) may be without effect on the yield until some "critical" nodulation stage is reached. Data on this point appear to be required.

Summary

Alfalfa seed, inoculated with a culture of *B. radicicola* retained viable organisms on their seedcoats for 6 months, capable of producing root nodules.

The method of inoculating seed by moistening with a suspension of the culture in sweetened skim-milk was superior to that whereby inoculated sand was mixed with the seed.

Storage at a moderately low, even temperature (in a refrigerator at 3° to 5° C.) appeared to be more favorable to nodule formation than at ordinary room temperature. As

far as could be determined, the fluctuating, low outside temperatures of the winter months appeared to affect adversely the nodule forming capacity of the seed.

Although the effect of inoculation was plainly noticeable after 6 months' storage, yet maximum nodule formation was only obtained with freshly inoculated seed.

Nodule forming capacity appeared to decrease more rapidly during the first week of storage, and more gradually thereafter.

Even after 24 hours' storage a decrease in nodule forming power was indicated, accompanied by a sharper decline in the number of colonies of *B. radicicola* appearing on plates of modified Ashby's agar.

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PRELIMINARY ANNOUNCEMENT OF THE FIRST INTERNATIONAL CONGRESS OF SOIL SCIENCE

In accordance with the decision of the Fourth International Conference of Soil Science that met in Rome, in May, 1924, the First Congress of the International Association of Soil Science, then organized, will convene on June 13, 1927, in Washington, D.C. The Congress will be followed by a field excursion to visit the various important soil belts in the country. Opportunity will also be given to the delegates to acquaint themselves with various Agricultural Industries, some of the leading Agricultural Experiment Stations, and in general with the agricultural resources of the United States.

The Association is made up of the following six International Commissions:—

I Commission on Soil Physics—

II Commission on Soil Chemistry —

III Commission on Soil Bacteriology—

IV Commission on Soil Fertility —

V Commission on Nomenclature, Classification and Cartography —

VI Commission on the Application of Soil Science to Land Cultivation—

The American representatives of these Commissions are:

I—Dr. C. Davis, Bureau of Soils, Washington, D.C.

II—Dr. M. M. McCool, East Lansing, Michigan.

III—Dr. S. A. Waksman, New Brunswick, N.J.

IV—Prof. D. R. Hoagland, Berkeley, Cal.

V—Dr. C. F. Marbut, Bureau of Soils, Washington, D.C.

VI—Dr. S. H. McCrory, Bureau of Agricultural Engineering, Washington, D.C.

Each Commission is now working on the preparation of its own programme. Some of the sessions will be devoted to the Congress as a whole, or to combined meetings of more than one Commission, while a number of sessions (5 to 8) will be devoted to the special sessions of each Commission.

The programme of each Commission will consist of papers presented by Invitation by outstanding Investigators in the respective fields, and of papers presented by various workers in the different branches of Soil Science, by members or non-members of the Association.

This Congress will bring together in this country, for the first time in its history, all those that are interested in the different problems of soil classification, soil analysis, fertilization and treatment, as well as the relation of the soil to plant growth. Extensive exhibits of various soil types (monolithic columns, in respective horizons) from Europe and America, apparatus used in soil analyses, of the soil microflora and microfauna, etc., will be held during the Congress.

Concerning the C.S.T.A.

APPLICATIONS FOR MEMBERSHIP

During the month of December the following applications for regular membership have been received:—

Aylard, A.W. (British Columbia, 1925, B.S.A.) East Sooke, B.C.

Briand, L.J. (Laval, 1921 B.S.A., McGill, 1925, M.S.A.) Chatham, Ont.

Davey, A.E. (Toronto, 1925, B.S.A.) Victoria, B.C.

Fraser, E.B. (British Columbia, 1925, B.S.A.) Vancouver, B.C.

Fowler, N.M. (Manitoba, 1926, B.S.A.) Winnipeg, Man.

Frith, R.C. (Toronto, 1922, B.S.A.) Ottawa, Ont..

Grest, E. G. (Saskatchewan, 1926, B.S.A.) Saskatoon, Sask.

LeBlanc, R. (Laval, 1925, B.S.A.) Meleghan, N.S.

Mustard, H.W. (Ont. Vet. Coll., 1908, V.S.) Vancouver, B.C.

McArthur, D.C. (Toronto, 1921, B.S.A.) Toronto, Ont.

Ostler, J.R. (Toronto, 1924, B.S.A.) Plevna, Ont.

Paterson, G.R. (Toronto, 1924, B.S.A., Iowa, 1926, M.S.) Clinton, Ont.

Phillips, S.S. (British Columbia, 1923, B.S.A.) Victoria, B.C.

Pomerleau, D. (Laval, 1925, B.S.A.) Cookshire, P.Q.

Reynolds, W.B. (Toronto, 1926, B.S.A.) Port Hope, Ont.

Wood, W.C. (Saskatchewan, 1926, B.S.A.) Saskatoon, Sask.

The total membership at the end of December was 974, including 10 student members.

It has been suggested that, in the event of the membership reaching 1,000 before the end of the Society year (May 31st), consideration be given to the advisability of maintaining the membership at that figure, admitting new members each year to take the place of resignations and deaths during the year. Those who recommend the adoption of this policy are of the opinion that it would not only reduce the number of resignations, but would also encourage more eligible members to submit their applications for membership than would do so while the total membership was unlimited.

Another proposal has been made that when any member has maintained a continuous membership for ten years, he should automatically become a Life Member, and have no further fees to pay. This suggestion requires careful consideration, but has a good deal of merit behind it.

FINANCES

The present Society year has advanced sufficiently to permit a statement being made that the reduction in annual fees from $6.00 to $5.00 will not cause a reduced credit balance at the end of the year, so that in all likelihood the lower fee will be continued indefinitely. The loss in revenue from fees this year has been balanced by an increase in membership and an increase in advertising revenue.

There are, of course, a number of members who have not yet paid their annual fees, and in making the above statement we are assuming that practically all outstanding fees will soon be paid.

There is so much misunderstanding as to the details of the Society's finances, that the General Secretary is now preparing a brief statement showing the sources of revenue and the channels of expenditure. This will be enclosed in the February issue of the magazine. If every member will take the trouble to read it, he will be surprised to learn how small a proportion of the Society's

operating expenses are covered by membership fees, and how much the C.S.T.A. is dependent upon the revenue from advertising. Roughly speaking it costs about $12.00 per member to operate the C.S.T.A., including the magazine, and of this amount the members are now contributing $5.00, or less than half.

1927 LIST OF MEMBERS

There have been so many changes and additions in the List of Members published in February, 1926, that a new list is now in course of preparation. It will be ready in February, 1927, and will be sent free to each member of the Society.

NOTES

J. D. Lanthier (Macdonald, '25) has been appointed Advertising Manager of *Farm and Dairy*, published at Peterborough, Ont.

F. J. Freer (Saskatchewan, '15) who has been District Superintendent of the Soldier Settlement Board at Winnipeg since 1921, is now Superintendent of the Canadian National Land Settlement Association, also at Winnipeg. He will have jurisdiction over the whole of Western Canada, as well as of the branch offices that have been established at Saskatoon and Edmonton.

W. A. Middleton (Macdonald '13) has just been appointed Provincial Horticulturist for Nova Scotia, with headquarters at the Agricultural College, Truro. He was extension assistant in horticulture at the University of B.C. from 1919 to 1925, and for the past two years has been operating a fruit farm at Vernon, B.C.

J. W. Graham (Macdonald '22) is now acting District Sheep and Swine Promoter for Nova Scotia, under the Dominion Live Stock Branch. His headquarters are at Truro.

W. H. Brittain (Macdonald '11), recently appointed Professor of Entomology at Macdonald College, addressed the Eastern Ontario branch of the C.S.T.A. at Ottawa on December 17th, outlining his recent world tour for the American Cyanimid Company. Fifty members were present.

The issue of *Scientific Agriculture* for May, 1927, will be devoted almost entirely to the development and scope of the poultry industry in Canada, and will feature the World's Poultry Congress, to be held at Ottawa the latter part of June.

Members of the C.S.T.A., when ordering books through the Society, are again reminded to furnish the name of the publishing house, as well as the title and author of the book required.

VACANCY FOR ASSISTANT PLANT PATHOLOGIST

The Dominion Civil Service Commission is advertising for an Assistant Plant Pathologist, Experimental Farms Branch, Dept. of Agriculture, at an initial salary of $1920 per year, with advances of $120 per year to a maximum salary of $2,280. Applications must reach the Commission not later than January 13th. Copies of the advertisement and application forms can be obtained from the General Secretary, C.S.T.A., the Secretary of the Civil Service Commission, Ottawa, or the Postmasters at Prince Rupert, Vancouver, Victoria, Edmonton, Calgary, Regina, Saskatoon, Winnipeg, Quebec, Fredericton, St. John, Charlottetown, or Halifax.

La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

Le Crédit Agricole en Belgique.

CHARLES GAGNE

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Les institutions de crédit à la disposition des agriculteurs belges sont les Comptoirs Agricoles et les Caisses Rurales ou sociétés coopératives à responsabilité solidaire et illimitée. (Caisses Raiffeisen). Les comptoirs ne s'occupent que du crédit foncier ou hypothécaire, tandis que les caisses rurales, aidées de leurs centrales, s'occupent de toutes les sortes de crédit agricole.

D'autres institutions, dites banques hypothécaires, bien que fondées dans le but d'aider les cultivateurs, ne font presque jamais de prêts à l'agriculture.

Avant de parler des comptoirs et des caisses rurales, il faut mentionner la Caisse Générale d'Epargne et de Retraite de Belgique.

La Caisse Générale d'Epargne et de Retraite

Cette institution fut d'abord fondée en vertu de lois votées en 1850 et en 1865 pour organiser l'épargne belge et constituer des pensions de retraite. Plus tard, en 1884 et en 1894, des lois spéciales devaient l'autoriser à avancer des capitaux à l'agriculture, par l'intermédiaire d'organismes particuliers.

La Caisse Générale d'Epargne et de Retraite, bien que surveillée par l'Etat, conserve un certaine autonomie administrative. Ses Conseillers avec son Directeur Général sont nommés par le roi et ses opérations sont garanties par l'Etat belge.

Elle ne peut prêter, pour fins agricoles, qu'aux comptoirs et aux caisses centrales de crédit coopératif. Et encore, la plus importante de ces dernières, celle de Louvain, a cessé toute opération avec elle depuis plusieurs années. En réalité, les avances de la Caisse Générale à l'agriculture sont peu élevées, comparativement à celles des Caisses Raiffeisen.

Les Comptoirs Agricoles

Ces comptoirs sont des associations libres, de propriétaires. Ils sont formés d'au moins trois personnes fortunées et compétentes en agriculture. Ces personnes se lient entre elles par un contrat de société en nom collectif et répondent ensuite, vis-à-vis de la Caisse Générale, de tout l'argent qu'elle prête par leur entremise. Le rôle des Comptoirs Agricoles est de s'enquérir des capacités ou de la solvabilité des emprunteurs, de surveiller les prêts en cours et de citer en jugement les débiteurs insolvables. Les membres reçoivent, en retour de leurs services, une commission ou "ducroire" de la Caisse Générale.

Le développement des Comptoirs Agricoles a été très lent depuis 1884, année de leur création, puisque, en 1923, leur nombre était de 18 seulement. En 1923, la Caisse Générale, par l'entremise des Comptoirs, a prêté 7,387,800 francs aux cultivateurs belges. (1) Cette somme était répartie en 573 prêts. Au dire de plusieurs coopérateurs belges les comptoirs agricoles n'ont pas réalisé les espérances des législateurs de 1884.

Les Caisses Rurales

Les sociétés coopératives à responsabilité illimitée du type Raiffeisen ont été implantées en Belgique en 1892, à la suite d'une campagne de presse de l'abbé Mellaërts, un des fondateurs du "Boerenbond", en faveur d'institutions populaires d'épargne et de crédit.

(1) Voir Revue Internationale des Institutions Economiques et Sociales. Rome 1926, Page 309.

La constitution, l'administration et le fonctionnement des Caisses Rurales belges ressemblent fort à ceux des caisses populaires établies dans le Québec par Alphonse Desjardins. Les caisses belges ne diffèrent des nôtres que théoriquement(2), au point de vue de la responsabilité de leurs membres. Le cultivateur belge, membre d'une caisse rurale est, en principe, responsable de tous ses biens en faveur de celle-ci, tandis que la responsabilité des membres des nos caisses populaires est limitée au montant de leurs parts sociales.

Les caisses rurales se sont constamment développées. Elles étaient au nombre de 1,338 en 1925, réparties surtout dans les provinces du Brabant, d'Anvers, des deux Flandres, du Limbourg et du Luxembourg.

Ces 1,338 caisses locales étaient affiliées, en 1923, à 9 caisses centrales opérant à: Louvain, Liège, Enghien, Arlon, Bruges, Ermeton--sur-Biert, Sivry, Gand et Namur.

En 1924, les 912 Caisses Rurales affiliées à la Centrale de Louvain groupaient 71,108 membres.

Ces caisses reçurent, la même année, 182,-216,003 francs de dépôts et effectuèrent des remboursements pour un total de 114,227,288 francs. De 1892 à 1924, il leur avait été confié une somme de 1,040,905,866 francs. De ce montant, à la fin de 1924, elles possédaient encore en dépôt, la somme de 385,479,364 francs.

Les mêmes Caisses locales consentirent, en 1924, 6,557 prêts représentant un capital de 53,945,101 francs; au cours de la période 1892-1924, elles ont accordé 78,234 prêts formant un total de 276,388,194 francs. Au 31 décember 1924, le montant de leurs prêts en cours s'élevait à 100,887,691 francs.

Au dire du Professeur Vliebergh, les caisses locales se seraient, dans leurs premières années, occupées plutôt de l'épargne que des prêts. Les chiffres de 1924 indiquent, il nous semble, une amélioration dans leur politique.

Les caisses locales tendent de plus en plus à ne pratiquer que les prêts à court terme, les opérations de crédit à long terme étant pratiquées surtout par les centrales. Les locales du groupe de Louvain, depuis 1892, ont fait 73,497 prêts avec cautionnement.

3,544 prêts avec hypothèque.
688 " avec privilège agricole.
488 " avec nantissement de titres.
37 " avec assurance sur la vie.

Les opérations des caisses paraissent très sûres, le total de leurs réserves se chiffrant, il y a deux ans, à 3,538,632 francs.

De son affiliation à une centrale, chaque caisse rurale retire, à part les services économiques, des avantages appréciables v.g. une plus grande confiance du public ou une direction sage et éclairée.

Pour mieux faire ressortir l'utilité des caisses centrales pour les locales, nous exposerons les activités de la caisse centrale de Louvain ou du "Boerenbond"(3). Celle-ci, résultat de la seule initiative privée, est de beaucoup, la plus importante de toutes les institutions de crédit agricole de la Belgique. Elle mérite d'être étudiée de près par les Canadiens qui songent à préparer un avenir durable à notre agriculture.

La Centrale de Louvain, fondée en 1895, groupe aujourd'hui près des ¾ (940 sur 1338, en 1925) des caisses rurales belges.

La Caisse Centrale de Louvain ou du "Boerenbond"

La caisse centrale de crédit de Louvain est une société coopérative à responsabilité limitée. Les membres souscrivent au moins une quote part de 100 francs et sont responsables jusqu'au décuple de cette somme. A part les caisses locales d'épargne et de crédit affiliées, seuls les individus élus par l'assemblée générale comme membres des conseils d'administration et de surveillance de la centrale peuvent en faire partie. Leurs souscriptions et leurs responsabilités sont les mêmes que celles des caisses. Les statuts stipulent que les parts de capital souscrites par les membres ne peuvent pas donner plus de 5 pour cent. En pratique, on ne leur accorde d'ordinaire que trois pour cent.

Le capital de la caisse centrale de crédit de Louvain s'accroît régulièrement, tant par suite de l'affiliation de nouvelles caisses d'épargne et de crédit que par le fait qu'à cha-

(2) Il me semble juste de dire qu'il n'y a qu'une différence théorique entre nos caisses populaires et les caisses Raiffeisen. En effet, l'esprit et le fonctionnement de ces institutions sont absolument identiques. La responsabilité illimitée des membres des caisses Raiffeisen n'est, en pratique, pas plus dangereuses que celle encourue par les membres des caisses populaires.

(3) Je dis: "Caisse centrale de Louvain ou du "Boerenbond" parce qu'il s'agit de la section de crédit de l'Union des Paysans belges (Boerenbond). Cette Union a son siège social à Louvain ainsi que ses diverses sections centrales.

que ouverture de crédit de 1,000 francs à une caisse affiliée ou, par l'intermédiaire de celle-ci, dans chaque opération de prêt foncier, cette locale souscrit une nouvelle part de 100 francs. Au 31 décembre 1925 le capital souscrit de la caisse centrale était de 6,-317,200 francs et son capital de garantie de 63,172,000 francs.

En plus d'augmenter le capital de la centrale, cette obligation imposée aux locales de souscrire une action de 100 francs, pour chaque 1000 francs empruntés de la centrale, a pour effet, pour les locales, d'ajouter à la responsabilité de leur emprunt celle de leur capital souscrit, c'est-à-dire de les obliger à être très prudentes dans leur administration. De même, la centrale se trouve à ne prêter jamais plus que le montant de son capital souscrit multiplié par dix. Cette stipulation des statuts est donc, en définitive, très propre à maintenir le crédit de la centrale et des locales.

La centrale dirige les quatre services suivants:

1.—Le contrôle des locales.

2.—Le service de renseignements, d'éducation financière et de propagande.

3.—Le service d'administration des dépots des locales.

4.—Le service des crédits.

1. *Contrôle*—Ce service est important. Il est exercé par des inspecteurs compétents qui, au moins une fois l'an et dans certains cas, plusieurs fois pendant l'année, doivent visiter chaque locale, en reviser les livres et toute l'administration. Chaque inspecteur rédige sur place un rapport qui doit être contresigné par les membres des conseils d'administration et de surveillance. Une copie de ce rapport est envoyée aux directeurs de la centrale. Ceux-ci visent à améliorer leur contrôle en le rendant aussi efficace que possible. Le professeur Vliebergh affirmait que ce contrôle avait toute l'efficacité désirable, puisque le refus d'une locale de se soumettre aux prescriptions des inspecteurs peut entrainer son exclusion de la centrale.

L'inspection se fait régulièrement; ainsi pour l'exercice de 1925, le rapport annuel dit que pour les 942 locales affiliées, les inspecteurs ont fait 1,453 visites d'inspection ordinaire et 22 visites d'inspection extraordinaire.

2. *Education financière, renseignements.*—La caisse centrale fait aussi l'éducation économique des administrateurs et des membres des caisses locales. Ainsi, dans le rapport de 1925, on voit que 86 nouveaux caissiers ont été mis au courant par les inspecteurs, que ceux-ci ont tenu 71 réunions de comités, assisté à 109 assemblées générales de caisses affiliées et donné 166 conférences sur le crédit agricole et le programme d'action des caisses.

La centrale tient à la disposition des locales un bureau de renseignements d'ordre juridique, v.g. pour résoudre les questions d'héritage ou les autres, pour aider les locales à régler leurs problèmes difficiles.

3. *Perception des Depots des Locales*—La centrale reçoit les dépots des locales qui, aujourd'hui lui apportent le gros de leurs épargnes, bien que les locales soient absolument libres de le faire où bon leur semble. Elle reçoit aussi les dépôts des particuliers.

On distingue deux catégories de dépôts faits à la Caisse centrale: *les dépôts à vue* "des caisses affiliées ou des particuliers" et les *dépots à terme de deux, cinq ou dix ans.*

Le total de ces dépôts s'élevait à:—
214,994,125 francs en 1919,
326,370,760 francs en 1921,
594,621,960 francs en 1924,
655,013,521 francs en 1925.

Pendant toute la guerre la centrale a payé 3 pour cent sur les dépôts à vue, tandis que les institutions financières belges ne payaient souvent que 1.50 pour cent.

Depuis 1917 les administrateurs de la centrale ont créé une nouvelle catégorie de dépots: les dépots à terme. La centrale paie un intéret plus élevé à ceux qui lui confient des fonds pour un certain nombre d'années. Ainsi, les épargnants peuvent déposer chez elles des sommes qu'ils ne retireront qu'après deux, cinq ou dix ans. En 1925, le montant des dépôts à terme était de 337,473,094 francs sur un total de 655,013,521 francs.

Ces dépôts à terme sont de deux sortes:

a) Les placements conditionnels.

b) Les placements fixes.

a) Placements conditionnels—Ces placements se font sur 5 ou 10 ans. L'intérêt pour les placements de dix ans est de 4.95 pour cent; pour ceux de 5 ans, il est de 4.40 pour cent. On appelle ces placements condition

nels parce que les déposants peuvent, toucher leurs capitaux avant l'expiration du terme, dans les cas suivants:

1.—Décès du déposant et décision des héritiers de rentrer dans leurs fonds.

2.—Achat ou construction d'immeubles.

3.—Pour établir les enfants qui se marient.

b) Placements fixes:—Ces placements se font pour deux, cinq ou dix ans. Jamais le déposant ne peut retirer son capital avant l'expiration du terme convenu. L'intérêt est de 5.5 pour cent pour le terme de dix ans; 4.95 pour cent pour le terme de 5 ans; 4.15 pour cent pour le terme de deux ans.

Pour les placements fixes, les déposants peuvent recevoir une simple quittance, avec inscription nominative dans les livres ou, s'ils le préfèrent, des titres ordinaires au porteur. Ces titres offrent l'avantage de réduire les formalités pour ceux qui prévoient la nécessité d'échanger leurs valeurs avant l'expiration du terme choisi.

Les dépots à terme permettent à la caisse centrale, depuis 1917, de prêter de l'argent à long terme et sur hypothèque aux paysans belges, sans recourir à l'émission d'obligations foncières, comme doivent le faire les autres institutions de crédit foncier. Comme les prêts à long terme ne suffisent pas à absorber le total des dépots à terme confiés à la centrale, cette dernière convertit la différence en bons d'Etat et en divers autres titres.

4. *Service des crédits*—La caisse centrale possède deux sections de crédit: le crédit à court terme et le crédit à long terme.

a) Crédit à court terme. Le premier but de la centrale étant de fournir aux locales pauvres des fonds à même les surplus des locales plus riches, les administrateurs ont ouvert des crédits aux locales affiliées. Dans le rapport de l'exercice de 1925, on lit ces lignes: "Nous avons consenti 157 ouvertures de crédit d'un total de 14,955,000 francs, alors qu'en 1924 nous en avions accordé 116, représentant un capital de 7,917,000 francs.

"Auprès de la caisse centrale étaient en cours, à la fin de l'exercice écoulé, 867 ouvertures de crédit s'élevant à 41,744,880 francs; de cette somme il n'a été utilisé effectivement que 25,172,082 francs".

Rapprochée des chiffres du rapport de 1897, alors que la centrale faisait ses 8 premières ouvertures de crédit à des locales pour un montant global de 19,550 francs, les chiffres de 1925 sont un témoignage éloquent du prodigieux développement de la centrale de Louvain.

b) Crédit à long terme. Une section intéressante de la caisse centrale est celle des prêts fonciers, section établie en avril 1904 pour servir au cultivateur dans les cas suivants: achat de terres, liquidation de successions, mariages et établissement des enfants. Les prêts sont remboursables par amortissements semestriels ou par annuités, sauf le droit de rembourser plus rapidement les sommes empruntées.

Ces opérations de crédit foncier ne doivent pas se confondre avec celles du crédit à court terme. La centrale ne pourrait pas utiliser, pour ses opérations à long terme, l'argent déposé à vue, chez elle, par les locales ou les particuliers, cet argent pouvant être demandé en tout temps par ses déposants. Pour prévenir les conséquences si redoutables d'une pareille confusion, les directeurs de la centrale eurent recours, de 1904 à 1917, à l'émission d'obligations foncières et, depuis 1917, ils ne prêtent sur hypothèque que l'argent déposé aux bureaux de la centrale pour 2, 5 ou 10 ans.

L'article 7 des statuts de la centrale dit: "Pour se procurer les fonds que les caisses locales affiliées, ou la caisse centrale directement prêteront sur hypothèque, la caisse centrale émettra des obligations foncières aux taux d'intérêt à déterminer par le conseil d'administration, de telle sorte que la valeur nominale des obligations en circulation ne dépasse jamais le montant des créances hypothécaires des caisses locales et de la caisse centrale, créances nées des prêts faits au moyen de fonds provenant de l'émission des obligations.

"Pour assurer cet équilibre, la caisse centrale retirera de la circulation par achat au tirage au sort le nombre requis d'obligations.

"Les obligations foncières peuvent être de 100 à 5000 francs pièce. Elles sont au porteur ou nominatives.

"Des coupons sont joints aux obligations pour la perception des intérêts semestriels.

"Le porteur d'une obligation ne peut en exiger le capital."

. Cet article fut en vigueur de 1904 à 1917 et la centrale n'eut jamais de difficulté à placer ses obligations foncières ou lettres de gage. Ces obligations, garanties par les hypothèques des emprunteurs et par la responsabilité des caisses, fournirent à la centrale, au cours de cette période tous les fonds nécessaires à ses opérations à long terme.

Comment sont accordés les prêts à long terme.—Les prêts à long terme de la Centrale s'effectuent de deux manières: 1.—Par l'intermédiaire des locales; 2.—directement aux cultivateurs, dans les endroits où il n'existe pas de locales.

1.—Par l'intermédiaire de la caisse locale. Dans la commune pourvue de caisse locale, les prêts s'effectuent exclusivement par l'intermédiaire de celle-ci. Le propriétaire foncier doit alors adresser sa demande aux administrateurs de la locale. Ces derniers examinent la demande, ainsi que les pièces requises, et, s'ils estiment le prêt utile, ils envoient le dossier à la Centrale. A la centrale on fait un nouvel examen du dossier, surtout au point de vue juridique. S'il manque quelque chose, on avise la caisse locale etle prêt n'est accordé que lorsque toutes les formalités sont remplies.

Le prêt se fait au nom de la caisse locale, par devant notaire. Sa durée peut être au plus de vingt-neuf ans et son montant ne peut excéder les deux-tiers de la valeur du terrain donné en gage. Les bâtiments qui s'élèvent sur ce terrain ne sont guère pris en considération. L'emprunteur paie semestriellement à sa caisse locale la somme convenue et comprenant l'intérêt avec une partie du capital, de sorte qu'au bout d'un certain nombre d'années il a complètement remboursé son emprunt.

La locale, après déduction de l'indemnité qui lui revient en propre pour ses services d'intermédiaire, fait parvenir le montant de chaque annuité à la centrale.

1. Prêts directs:—Si dans la commune de l'emprunteur, il n'y a pas de locale, celui-ci doit s'adresser directement à la Centrale. Cette dernière est alors plus exigeante; elle demande un intérêt plus élevé et ne prête qu'à concurrence de 60 pour cent de la valeur en gage.

L'initiative du "Boerenbond", en matière de crédit à long terme fut critiquée à ses débuts. Elle s'est pourtant révélée comme l'une des plus heureuses tentatives faites par des coopérateurs en Europe. Et les Belges se glorifient avec raison, d'avoir obtenu leur magnifique succès en se passant de toute intervention officielle.

Si jamais nos caisses populaires doivent nous donner du crédit à long terme, nous devrons, pour compléter leur organisation, prendre modèle sur Louvain. A ceux qui feront l'objection que les caisses populaires sont au service de tout le peuple et non pas seulement au service des cultivateurs, il sera facile de répondre qu'une section de crédit à long terme peut très bien fonctionner au siège d'une Union Régionale, sans nuire aux caisses locales urbaines affiliées à cette Union.

Bientôt nos législateurs d'Ottawa nous donneront une organisation fédérale de prêts agricoles. Même si celle-ci devait être des meilleures, nous ferions bien nous du Québec, de nous organiser chez nous, indépendamment des autres provinces et de l'Etat. Car aucun des gouvernements d'Ottawa ou de Québec ne pourra jamais faire mieux, ni même aussi bien, que les coopérateurs de Louvain. Or nous avons, dans notre province, tous les éléments qui ont permis aux Belges indépendants et libres de réussir; il ne nous manque que de compléter l'organisation de ces éléments.

Pourquoi, en prenant le temps et les mesures de prudence requises, ne pas le faire? Ce serait accomplir une étape importante de plus dans l'affranchissement économique de notre agriculture.

OUVRAGES CONSULTES

(1) "Les Associations agricoles en Belgique". Max Turmann, Paris, 1909.

(2) Elements d'Economie Rurale non technique. Prof. E. Vliebergh, Louvain, 1922.

(3) Bulletin des Institutions Economiques et Sociales. Rome, Série 1910-1922.

(4) Revue Internationale des Institutions Economiques et Sociales. Rome, Avril-Juin, 1926.

(5) Rapports annuels des activités du Boerenbond. Louvain, années 1922-23-24-25.

Activités des Sections.

Section de Montréal

Mgr. Allard, président des Missionnaires agricoles et curé de la paroisse de Ste. Martine, comté de Chateauguay, a été le conférencier du diner-causerie tenu le 18 décembre, au cercle Universitaire de Montréal.

Monsieur H. M. Nagant, président de la section de Montréal, présenta le conférencier.

A cette occasion, il fit ressortir combien est enviable le sort d'un agronome qui dans son comté et dans sa paroisse peut compter sur l'appui sans réserve d'une personnalité ecclésiastique aussi sympathique, aussi bien au courant des questions agricoles que l'est Mgr. Allard, lequel, de plus, à son crédit plusieurs oeuvres d'organisation agricole.

Le conférencier, en un tableau historique des plus impressionnants, démontra l'action féconde de l'Eglise dans le développement de l'agriculture au cours des siècles de christianisme.

Il dépeignit surtout d'une façon saisissante, le rôle des moines défricheurs, en Italie, en France, en Allemagne et en Angleterre, au cours du moyen-âge.

Par le développement de leurs vastes abbayes, ils créèrent dans tous les pays, des centres d'une agriculture très prospère, assurant une subsistance large et heureuse à des milliers de travailleurs du sol. Les suppressions et confiscations de ces abbayes, au cours de la période moderne, furent un grand melheur pour la prospérité agricole de plusieurs des pays mentionnés plus haut, dont les effets se font encore sentir actuellement, en Angleterre notamment.

Monsieur Nolasque April, Agronome officiel du comté de Chateauguay, qui peut se féliciter d'être le paroissien de Mgr. Allard, remercia celui-ci, en termes fort bien choisis, au nom de l'assemblée.

Parmi l'assistance de 35 personnes, signalons comme convives en dehors de la section de Montréal. Messieurs J. Chs. Magnan, Agronome officiel à St. Casimir, Monsieur L. Ph. Roy, Chef du Service de la grande Culture de Québec, Mandeville de la coopérative fédérée, etc.

H.M.N.

Une conférence du R. F. Marie Victorin

A ceux qui n'en auraient pas pris connaissance, nous tenons à signaler la conférence faite par le R.F. Marie Victorin, à l'assemblée générale de la Société d'histoire naturelle, à Montréal, le 9 octobre dernier, et dont le texte a été publié dans les numéros des 15 et 13 novembre du Devoir, sous le titre de "*La science et nous*".

Cet ardent plaidoyer en faveur des sciences naturelles se fait remarquer autant l'élévation de la pensée de l'auteur que par les développements originaux qu'il lui donne.

Souhaitons un franc succès au R. F. Marie-Victorin dans sa vigoureuse campagne contre l'indifférence encore si générale régnant à l'égard des sciences naturelles qui ont cependant un domaine si riche et si intéressant, à exploiter dans un pays comme le Canada.

The Effect of Pruning on the Growth of the Tomato.*

JOHN WALKER

Dominion Experimental Farm, Indian Head, Sask.

INTRODUCTION

At frequent intervals during the past quarter century, papers setting forth the results obtained, and conclusions deducted from experiments on pruning the tomato have appeared in horticultural literature. That experiments of this nature should yield varying and oftimes conflicting results in the hands of different workers, can only be expected, since the factors conditioning growth and development in no two places are identical. The personal equation also introduces the possibility of extreme variation in the interpretation of results. Results are often obscured by the loose application of horticultural terminology, and the peculiarities of the variety or varieties under test are frequently overlooked in comparing results.

The purpose of this paper is to present in detail results obtained from growing tomato plants of two varieties, viz., Alacrity, a variety of the Earliana type with sparse foliage, and Bonny Best, under conditions of intensified single stem pruning. The pruning consisted of stopping logitudinal growth after the differentiation of the first, second, and third trusses of blossoms, as compared to non-stoppage of growth. An attempt will be made to ascertain the significance of these results in so far as the growth of the tomato is concerned.

Literature Review

Before discussing investigations comparable to the study to be reported, a general review of those encompassing the pruning of tomatoes to varying numbers of stems as compared to unpruned plants, seems desirable. With the information and conclusions gleaned therefrom in mind, we shall be in a better position to comprehend and analyze the effects, if any, of the intensified pruning as performed in the present study.

In reviewing data dealing with the pruning of the tomato, one does not find a very close agreement in results obtained by different investigators. One can hardly expect that treatments applied to plants growing in the southern or middle states will produce the same responses when applied to plants growing in the northern states or Canadian provinces. Environmental factors, e.g., light, temperature, length of growing season, precipitation and soil fertility at places from which these experiments have been reported, vary individually or collectively to such an extent as to render a comparison of results misleading. Contrary statements concerning the results of experiments in certain localities are also encountered.

Investigations on the effects of pruning the tomato are by no means a present day innovation. In 1891, Munson (28) at Maine found that trimming tomato vines hastened the maturity of fruits, besides increasing the average number and weight of fruit obtained. Effects of pruning the tomato were reported by Bailey (2) in 1892 who concluded that trimming did not yield decided results. The total product for the season was given by him as four pounds to nine pounds—trained to untrained vines. Under Minnesota conditions, Green (8) in 1894 stated that there was no profit in the practice of staking and trimming tomatoes, and that results as to earliness were very much in favor of the plants that were not staked.

Early in the present century when tomato growing commenced to assume extensive proportions, investigations were initiated to find out the effects of pruning or training and staking the tomato in so far as earliness of the ripening of fruit, amount of early fruit, total yield of tomatoes per plant, total yield of marketable tomatoes, size of tomatoes and percentage of the crop which ripened, were concerned.

*From a thesis submitted to the faculty of the graduate school of the University of Minnesota in partial fulfillment for the degree of Master of Science.

Data are presented by Lloyd and Brooks (18) which indicate no uniform relation between pruning and the date of the ripening of the earliest fruit. They also found that plants pruned to single stems were comparatively low in early yields. After three years' study, these workers found that in only one case did the plants pruned to single stems produce the largest fruits. The total yield per plant was also reported by them as being reduced in proportion to the severity of the pruning. Physiological injuries such as sunburning, cracking, and blossom-end rot, were equally prevalent on pruned and unpruned plants.

Whipple and Schermerhorn (44) obtained ripe fruits from pruned plots twenty days earlier than from unpruned plots of the same varieties. These workers also found that pruning greatly increased the total yield of ripe fruits, and improved the quality of fruits ripened. They also reported that though pruning did reduce the total yield when both green and ripe fruits were considered, the green fruits were usually of little value.

In experiments carried on by Wicks (45) the greatest number of first ripe fruit was obtained from plants pruned to one stem, and the total yield per plant was reduced in proportion to the severity of the pruning. Wicks, moreover, stated that the smallest number of culls was picked from plants that were pruned to one stem, followed in order by two-stemmed, three-stemmed, and unpruned plants, the latter yielding the greatest number of culls.

Concerning pruning and staking tomatoes, Stuckey (40) observed that the length of the bearing season of the pruned and staked plots was twice that of the unstaked unpruned plots. He also found that fruits from the former plots were larger and freer from defects, except blossom-end rot, than those from the latter. In Stuckey's experiment all the pruned and staked plots gave a much higher yield than the unpruned unstaked plots, that in which the plants were pruned to three stems giving the highest yield.

Discussing the effects of staking tomatoes, Wilkinson (46) advocated pruning and staking to obtain early fruits, and no pruning or staking to obtain a large yield and a large percentage of culls.

The variety factor is considered by Olney (31). He concluded after three years' trial that some varieties seemed to be influenced more than others by pruning, and stated that tomatoes staked and pruned ripened approximately one week earlier than those untrained. Olney also obtained affirmative results from pruning regarding size of fruit, and total yield per plant was reduced in proportion to the severity of the pruning. Little difference in the number of diseased specimens from pruned or running tomatoes was reported by him.

From various Canadian experimental stations tomato pruning experiments are reported. Reed (34, 35) found that staking and pruning to one stem hastened maturity, and increased the amount of ripe fruit considerably. No difference from pruning in date of first ripe fruit was reported by MacKenzie (19), who, however, observed that plants pruned to one or two stems, and with the foliage partly removed ripened about fifty per cent of the crop. The following table from MacKenzie (19) bears this out, and indicates that unpruned plants of two varieties produced heavy crops of green fruit.

Two Years' Average 1921, 1922—10 Plants.

Variety	Treatment	Two years' average yield in lbs.		
		Ripe	Green	Total
Alacrity	Unpruned	25.0	214.0	239.0
Alacrity	1 stem	52.75	77.0	129.75
Alacrity	2 stems	71.0	51.5	122.5
Bonny Best	Unpruned	32.5	153.5	186.0
Bonny Best	1 stem	38.0	43.5	81.5
Bonny Best	2 stems	50.0	54.0	104.0

Regarding ripe fruit, Munro (25) found the amount considerably greater where the plants were trimmed to one stem. The same worker obtained the greatest yield from plants trimmed to two stems. He also reported (26) no matured fruit from those plants which were not trimmed and staked.

After many years of investigation McKillican and Cooper (24) concluded "in order to ripen fruit in satisfactory quantities in the climate of Western Canada . . . the tomato plant must be trained to single or double stems and pruned to reduce side branching. . . . The staking and pruning have advanced the appearance of ripe fruit from one to three weeks according to the season". McKillican (22) obtained data which show very conclusively that the practice of staking and pruning is a most effective means of increasing the yield of ripe fruit. Further data supporting this conclusion, are presented by the same worker(23),who also contends that two-stemmed plants always do better than the one-stemmed ones.

That pruning was effective in increasing the amount of ripe fruit was observed by Tinline (41) who reported the heaviest total yields from unpruned plants with green fruit varying considerably in size.

On the other hand, Langelier (15) stated that pruning cut down the ripe crop, the green crop, and the total yield in fifteen varieties with a single exception. Likewise Straight (38), commenting on methods of training tomatoes in many years' experience, stated that so far as culture in the open is concerned, pruning of any description is a waste of time.

A very comprehensive table setting forth results obtained from staking and pruning tomatoes is given by Fretz (5), a commercial grower. The table furnishes evidence that pruning hastened maturity and increased the yield of early ripe fruit. Not until the fourth week was the yield from the plot pruned to one stem surpassed. A report by Magruder (21) bears a strong resemblance, and from Ohio (30) results very similar to those presented by Fretz (5) were also obtained. In the Ohio experiment the fruit borne by the single-stem plants was larger than that from other pruned or unpruned plants.

The work of other experimenters may be summarized as follows: Lewis (17) credits staking and pruning with only slightly hastening the earliness of maturity in tomatoes. Rosa (36) noted no advance in the date of ripening, but stated that the highest per cent of early fruit was produced by plants staked and pruned to one stem, while the largest total yields were obtained from plants neither staked nor pruned. Somewhat similar conclusions were drawn by Quinn (33). Hood (11) believed that the tomato plant would do better and produce more ripe fruit when allowed to grow at will. He noted, however, that size and quality of fruit were favored by pruning, though total yield was reduced accordingly.

Thompson (43) discusses pruning the tomato, and concludes that there is practically no advantage in earliness in favor of the practice in the north. Neither does he believe that the size of fruit is benefitted by pruning.

Notwithstanding these contentions, after trials extending over ten years at the Mandan Station N.D. (37), it was found that "ordinary field culture proved of little value, as the crop matured so late that the largest part was destroyed by frost. To mature the crop it was found necessary to stake and prune to a single stem".

In the 1922 report of the Research Commission of the Vegetable Growers' Assn. of America, the results of experiments on pruning tomatoes in Illinois, Missouri, New York and elsewhere, are discussed. The following statement is made, "No compensating advantages in earliness and quality have shown up. All of the experiments in the Northern States have given similar results, and they are conclusive and all show that pruning tomatoes is injurious". (Surely a misleading and unjustified statement to make in view of *some* of the experiments conducted in one or two of the most northerly states).

General Conclusions from Literature Review

In spite of the apparent contradictory results obtained by workers throughout the continent from presumably similar experiments, the data herein reported seem to warrant the following rather general conclusions;

1. Length of growing season:

If a considerable portion of ripe fruit is desired in latitudes of a 99-100 day frost-free period, pruning the tomato to one or two stems is desirable.

2. Earliness:

Where earliness is of prime importance, checking the vegetative growth by pruning is commendable.

3. Size and quality of fruit:

Improvement in size and quality of fruit was demonstrated by pruning.

4. Disease control:

In districts where foliage diseases are prevalent, the practice of pruning the tomato may be considered a method of control, since the application of remedial and preventative measures is facilitated.

Statement of Problem

The conditions as outlined in the preceding conclusions under which pruning the tomato is recommended are with one exception (4) found in the prairie provinces of Western Canada. Throughout this area, the single stem system of growing tomatoes has been advocated and adopted very largely. More detailed information, however, on the behavior of the tomato growing under northern conditions was desired and an experiment was outlined in which the growth of plants was further controlled by stopping* longitudinal growth after the differentiation of the first, second, and third trusses of blossoms.

In this study, groups of plants of two varieties "stopped" as indicated, and other groups which were not "stopped" were compared with respect to earliness of ripening of fruit, amount and per cent of fruit ripe, total yield of fruit, relation of set of fruit on one truss to that on another, flower differentiation and development, and average weight of fruit.

Throughout this paper, the various groups of plants will be referred to as follows:

"Stopped" at first truss—Lot I.
"Stopped" at second truss—Lot II.
"Stopped" at third truss—Lot III.
"Non-stopped"—Lot IV.

Methods

Commercial seed of two varieties of tomatoes, viz., Alacrity and Bonny Best, was sown in a greenhouse on April 4, 1925. Plants were grown in pots under normal methods of culture, and set in the garden at the Experimental Farm, Indian Head, Sask., on June 17. Seventy plants of each variety were planted one foot apart in rows two feet apart and staked immediately. The soil was a heavy clay of uniform consistency and fertility.

Beginning at one end of the rows, seventeen plants of each variety were marked off for each treatment. By this means, at the north ends of the rows, plants of the Alacrity variety "stopped" at the first truss were directly opposite those of the Bonny Best variety similarly treated. Then followed those "stopped" at the second and third trusses, and the "non-stopped" plants of each variety at the south ends of the rows.

(See Plates I and II, Figs. I, II, III, and IV)*

In lots 1, the plants were "stopped" as soon as the first flower truss had differentiated by pinching off the growing point at the axil of the leaf immediately above the flower truss. The terminal growing point was likewise removed after the differentiation of the second flower truss on lots II and after the third on lots III. All side growths subsequently developing on the plants were removed from all lots whenever they appeared and tying to stakes attended to as required. Lots IV were maintained as single stem plants whose longitudinal growth was checked late in the season.

Favorable conditions for the development of the tomato attended the experiment. Warm and dry though the season was, none of the plants suffered from drought on the clay soil. The tomato being normally self fertilized, pollination was considered efficient for the purpose of this study.

Blossom counts on all trusses of lots I, II, and III, were made on July 20 and August 4. An average of these two counts is included in Table IV. On August 4, many fruits had set, and a number of blossoms had abscissed. Abscission scars were most numerous on the early differentiated trusses of the Alacrity variety. The counts, therefore, do not represent accurate differences between lots and varieties, but illustrate the existing relationship.

Five representative plants in each lot were selected, whose leaves below the first truss were measured on July 24. Leaf index values were considered but mature tomato leaves do not lend themeslves to accuracy with such

* Stopping is used in preference to pruning as it conveys the meaning of the practice better.

*It may be stated here that the "non stopped" plants were "stopped" after the fifth truss had differentiated when some fruit had ripened on the vines.

PLATE I.

Fig. 1. Bonny Best "stopped" at first truss.

Fig. 2. Bonny Best "stopped" at second truss.

Fig. 3. Bonny Best "stopped" at third truss.

Fig. 4. Bonny Best "non-stopped" plants.

measurements. Lengths of leaves were, therefore, taken to illustrate the point in mind.

Fruit was picked when showing red over the entire surface. The first ripe fruits were harvested on August 14, when a few of both varieties were secured. The number and weight of fruit obtained from each truss were carefully recorded for each plant. On September 9, the last ripe fruits were picked, and all unripe fruits were harvested, and weighed on September 11 and 12. An impression of the condition of the plants in each lot on August 17 may be obtained from the figures in Plates I and II. The plants shown represent the various lots very favorably, and are arranged so that the two varieties may be compared while treatments are being examined.

Experimental Data

In order to facilitate interpretation, the data obtained will be presented under various headings. These will be taken up in the most logical order and the results of other workers from similar experiments will be included.

Effect on Earliness—In Table I, the numbers and weights of ripe tomatoes harvested in six day periods from the various lots are given. It will be seen that in both varieties the number, but not the total weight, of fruits, was slightly greatest from lots 1 at the end of

the second period. The increase, however, is hardly significant, and only three days elapsed (August 14-17), between the time of harvesting the fruits shown in the first column of Table I, and some of those in the second column.

Munro (27) found that "cutting back to one bunch decreased the yield, and did not hasten maturity sufficiently to warrant the practice." Very little difference in earliness was noted by Tinline (42), whether the plants were checked at one truss or at three trusses. Clark (3) discussing the effect of this method of pruning states, "little effect on the date of maturity was noted". "No advantage in earliness by stopping at the first truss under conditions at Brandon" is reported by McKillican (23). Leslie (16) "found no considerable difference in earliness of ripening between the three lengths of stems".

On the other hand, Hicks (10) states, "the result of this experiment as a whole shows that earliness in producing ripe fruit is obtained where the plants are headed back to one, two and three trusses in the order mentioned, though in the case of the Bonny Best, the plants not headed back were the earliest". Gibson (7) also presents a table of data which indicates that fruit ripened on the plants stopped at the first truss seventeen days earlier than on any of the other trusses for Alacrity, and five days for Bonny Best.

Ripe Fruit and percent of Fruit Ripe—By referring to Table II where yields by six-day periods are "carried forward", considerable va..iation with respect to numbers will be observed. In the Bonny Best variety the race for supremacy favors lot 1 until the third period, when lots II and III forge ahead. With Alacrity, lot 1 is a strong contestant for the first place throughout the whole period, yielding a greater number than lot III, and only nine tomatoes less than lot II, of ripe fruit.

When weight of fruit is studied, however, results are particularly uniform in that lots II and III assume an early advantage which increases as the season advances. In both varieties the fact that lot II produced the largest number of ripe fruits and the greatest weight of ripe fruit in a given time is most significant.

In Table III yields of ripe fruit from individual trusses are given on a percentage basis. From the figures a clearer conception of the behavior of the plants in each lot is obtained.

TABLE I.

Yields of Tomatoes in Numbers and Weights at 6 day intervals from 17 Plants representing each treatment.

Variety and Treatment	August 11—16 No. fruit	Wt. oz.	August 17—22 No. fruit	Wt. oz.	August 23—28 No. fruit	Wt. oz.	Aug. 29 No. fruit	Sept. 3 Wt. oz.	Sept. 4—9 No. fruit	Wt. oz.	Total ripe Fruit No.	oz.	Sept. 10—15* No. fruit	Wt. oz.	Total Yield for season No. fruit	Wt. oz.
Bonny Best "Stopped" at first truss	3	8.5	27	95.5	12	39.0	6	30.0	9	27.25	57	200.25	34	121.5	91	321.75
Bonny Best "Stopped" at second truss	—	—	19	84.5	16	66.5	22	110.0	30	122.0	87	383.0	118	346.5	205	729.5
Bonny Best "Stopped" at third truss	—	—	29	120.5	12	51.0	15	68.5	26	120.0	82	360.0	206	614.0	288	974.0
Bonny Best "Non-stopped"	—	—	18	64.5	13	49.0	13	55.0	34	151.5	78	320.0	300	530.5	378	850.5
Alacrity "Stopped" at first truss	5	10.0	71	132.5	10	23.0	60	109.0	11	10.0	157	284.5	69	124.5	226	409.0
Alacrity "Stopped" at second truss	—	—	66	205.5	17	59.0	56	136.5	27	69.5	166	470.5	165	353.5	331	824.0
Alacrity "Stopped" at third truss	3	19.0	70	195.5	16	46.5	26	83.0	34	88.0	149	432.0	257	502.0	406	934.0
Alacrity "Non-stopped"	—	—	64	163.5	18	73.5	17	65.5	43	132.5	142	435.0	315	629.0	457	1064.0

*Figures in this column represent numbers and weights of unripe fruit.

Considering the percent of fruit ripened on the first trusses, there is within varieties but slight variation throughout the series, with the exception of lot 1, Alacrity. It will be observed that in lot IV the percent of fruit ripened on the first truss compares favorably with that on other lots.

Figures denoting percent of fruit ripened on second trusses show a certain relationship in that the decrease in percent ripened is as the increase in trusses per plant. It is of particular interest to note that the greater number and weight of ripe fruit produced by lots II in both varieties represents a much higher percent of total crop ripened than on the other lots, with the exception of lot 1.

The most outstanding feature in this connection is the almost complete failure of any fruit to ripen on the third and subsequent trusses in lots III and IV of both varieties.

TABLE II.
Yield of Ripe Fruit—Accumulated Totals* at 6 Day Intervals.

Variety and Treatment	Aug. 17-23 No. of fruit	Aug. 17-23 Wt. in oz.	Aug. 23—28 No. of fruit	Aug. 23—28 Wt. in oz.	Aug. 29 Sept. 3 No. of fruit	Aug. 29 Sept. 3 Wt. in oz.	Sept. 4—9 No. of fruit	Sept. 4—9 Wt. in oz.
Bonny Best "Stpd" at 1st truss	30	104.0	43	142.0	48	173.0	57	200.25
Bonny Best "Stpd" at 2nd truss	19	84.5	35	151.0	57	261.0	87	383.0
Bonny Best "Stpd" at 3rd truss	29	120.5	41	171.5	56	240.0	82	360.0
Bonny Best "Non-stopped"	18	64.5	31	113.5	44	168.5	78	320.0
Alacrity "Stpd" at 1st truss	76	142.5	86	165.5	146	274.5	157	284.5
Alacrity "Stpd" at 2nd truss	66	205.5	83	264.5	139	401.0	166	470.5
Alacrity "Stpd" at 3rd truss	73	214.5	89	261.0	115	344.0	149	432.0
Alacrity "Non-stopped"	64	163.5	82	237.0	99	302.5	142	435.0

*Figures obtained from Table I.

TABLE III.
Per Cent. of Total Number and Weight of Fruit Ripe*

Treatment and Truss Number		Bonny Best		Alacrity	
		% Number	% Weight	% Number	% Weight
"Stopped" at first truss	1	62.6	62.2	69.4	69.5
"Stopped" at second truss	1	63.5	73.4	53.7	63.6
	2	23.8	28.4	40.4	37.2
"Stopped" at third truss	1	58.4	67.7	55.6	67.6
	2	23.1	33.3	15.4	17.4
	3	1.1	0.5	6.0	4.3
"Non-stopped"	1	63.7	74.1	58.2	66.3
	2	18.5	30.9	13.4	21.2
	3	2.3	3.2	4.1	4.7
	4	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0

*Calculations made from data of Table II.

This bears a practical significance in that under climatic conditions resembling those accompanying this study, plants should be "stopped" after the differentiation of the third truss, if only ripe tomatoes are desired. Further support to the adoption of this practice is obtained by studying Table VI, where the average weight of all fruit from the fourth and fifth trusses in both varieties is only slightly over one ounce, indicating relative immaturity.

The percent of ripe fruit on plants comparable to lots I, II and III, Munro (27) reports, as 41, 37 and 27 respectively. Clark (3) states "heading back the plants increased the amount of fruit ripened", and gives the following table:

PER CENT RIPE FRUIT (Clark) (3)

Treatment	Bonny Best	Alacrity
First Truss	100.0%	100.0%
Second Truss	98.8%	99.3%
Third Truss	93.6%	97.5%
Not headed back	82.9%	76.4%

Clark's recommendation is: "to procure a large amount of ripe fruit at little sacrifice in yield, prune to a single stem, and head back the plant at the third truss". Referring to the results of this experiment Hicks (10) states: "in all instances the more trusses the more ripe fruit was obtained as a total yield". "Those not headed back gave a very small yield of green fruit with none ripened" writes MacKenzie (20).

Total Yield—The total yield for the season by numbers and by weight is given for each lot in Table 1. With only one exception, total yields by weight were inversely as the severity of the pruning. This condition is only to be expected since the development of fruit bearing appliances and food manufacturing organs was inhibited by "stopping" the plants.

Straight, (39) believes that no pruning is necessary under coastal conditions and states: "any mutilation of the tomato vine results in less fruit and the greater the mutilation the greater the loss." Comparative figures given by Munro (27) are 57, 92 and 154 pounds representing total yields of first, second, and third truss plants respectively. Under conditions at Brandon, Tinline (42) found that "checking at one truss decreased the yield of both ripe and green fruit". Likewise, McKillican (23) reports; "the most severe checking has greatly reduced the amount of fruit both early and late; checking at two and three trusses has not made any particular difference in the yield."

At Beaverlodge, Albright (1) was led to the following conclusion: "the trimming to two trusses shows an advantage of more than 25% over trimming to one. There was little apparent advantage in trimming to three trusses as the third truss proved a negligible quantity when left on." Leslie (16) also reports the lowest yields from plants bearing the least number of trusses, while MacKenzie (20) found that "with each sort the heaviest yields were from plants pruned to the third truss."

Blossom Differentiation and Fruit Setting—In Table IV the average number of blossoms, average number of fruit set, and percent of blossoms which set fruit per truss in each group are given. To what extent the factors of environment and heredity, respectively, are responsible for these results, cannot definitely be stated. That physiological phenomena are involved cannot be questioned, and the uniformity in blossom counts on the trusses of Bonny Best clearly indicates a stability in character manifestation. Counts of blossoms on the "non-stopped" lots were unfortunately not made but the number of fruits harvested from the first, second and third trusses of these plants of both varieties, gives further evidence of varietal characteristics.

The relationship between the blossom count and number of fruit which developed on the first and second trusses in the Alacrity variety is fairly constant throughout. There is also positive evidence that in this variety flower differentiation and fruit development on the first trusses suppress like phenomena on later formed trusses. No such influence was manifested in the Bonny Best variety.

In Alacrity, there is a slight indication of increased flower bud differentiation as a result of checking longitudinal growth at first truss e.g., 24.67 on lot 1 as against 20.58 for the first truss of lot II. This difference may not be statistically significant, but when the number of blossoms which had abscissed at the time of the second count is given consideration, the difference might be said to be actually greater. The counts on individual plants, however, were

TABLE IV.
Blossoms Differentiation and Fruit Setting

Treatment and	Truss Number	Bonny Best: Number of blossoms average of two counts	Bonny Best: Number of fruit set & harvested Aver. count	Bonny Best: Percent of blossoms set fruit	Alacrity: Number of blossoms average of two counts	Alacrity: Number of fruit set & harvested Aver. count	Alacrity: Percent of blossoms set fruit
"Stopped" at first truss	1	7.8	5.3	68.1	24.6	13.3	53.8
"Stopped" at second truss	1	7.0	5.6	80.6	20.5	14.2	69.1
	2	8.0	6.4	79.5	9.0	5.2	57.6
"Stopped" at third truss	1	7.4	5.9	79.5	18.7	13.5	72.1
	2	7.0	5.5	78.8	9.0	6.4	71.4
	3	7.5	5.4	71.5	7.0	3.8	54.7
"Non-stopped"	1	—	5.3	—	—	12.8	
	2	—	5.7	—	—	5.2	
	3	—	5.1	—	—	4.2	
	4	—	2.8	—	—	2.8	
	5	—	2.8	—	—	1.7	

in close agreement, so that the average of the two counts is representative of each lot. In this respect the most outstanding difference in behavior of the two varieties is illustrated.

The figures in column three of Table IV are of interest in that they indicate the type of pruning which creates within the plants the best balance between the complex factors governing vegetativeness and reproductiveness. In neither variety was the set of fruit on the first truss nearly as high in lots 1 as in lots II and III. It cannot be said that the number of blossoms was wholly concerned, since there was practically no variation in this respect throughout the Bonny Best series.

As a correlative, the average lengths in centimeters of leaves inferior to the first flower truss of five plants representative of each lot is given in Table V.

TABLE V.

Lengths of Mature Leaves.

Variety	Treatment	Average No. of leaves per plant	Average lengths of leaves in centimeters
Alacrity	Lot I	7	28.10
Alacrity	Lot II	6	27.06
Alacrity	Lot III	7	28.31
Alacrity	Lot IV	6	27.81
Bonny Best	Lot I	5	33.45
Bonny Best	Lot II	6	31.71
Bonny Best	Lot III	6	31.02
Bonny Best	Lot IV	6	32.67

A conspicuous difference between the varieties is apparent. The greater leaf area of the Bonny Best variety no doubt influenced the percent of blossoms which set fruit, by proportionately increasing the supply of available carbon synthates.

Size and Average Weight of Fruit—While relative size of fruit is a stable varietal characteristic, the occurrence of variation within varieties is universal common knowledge. This condition is pertinently illustrated in Table VI.

Only in the columns where the average weight of the total crop is given is there any degree of correlation, but no very definite deductions can be made therefrom. On the various lots, however, in both varieties, a regular decrease in weight from the first to subsequent trusses is indicated. A similar relationship is also suggested with respect to average weight of ripe fruit of the Alacrity variety.

There is little evidence that the adopted methods of pruning materially affected the size of the fruit produced, except in the case of lot 1, Alacrity. From the figures obtained for this group the reason for the comparatively low weight, as compared to number of ripe fruit from lot 1, Alacrity, as shown in Table II is elucidated.

Discussion

In view of the nutritional, microchemical, and anatomical studies that have been made with tomato plants grown under apparently

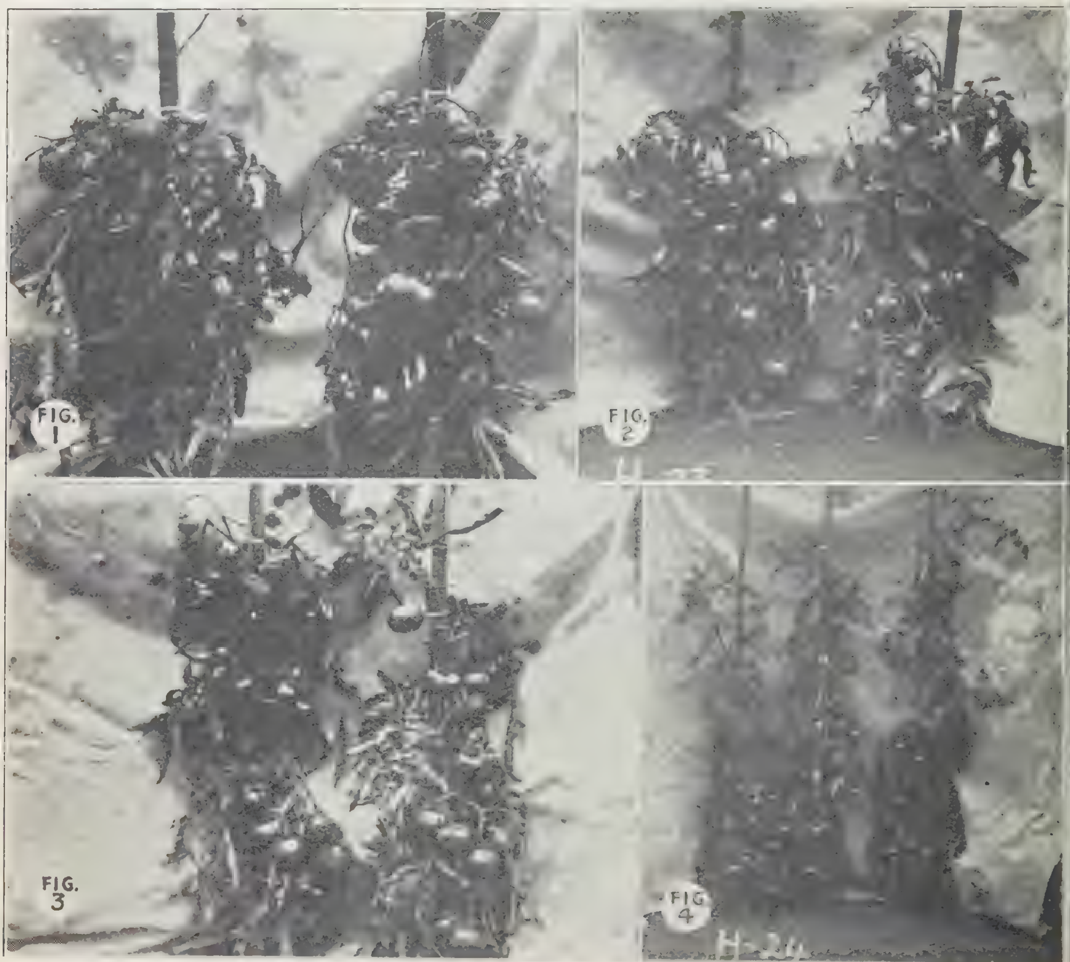

PLATE II.

Alacrity "stopped" at first truss.

Fig. 2. Alacrity "stopped" at second truss.

Fig. 3. Alacrity "stopped" at third truss.

Fig. 4. Alacrity "non-stopped" plants.

control conditions, the results reported here are of particular interest.

That the condition of fruitfulness or vegetativeness of a plant may be considered the expression of the correlation between internal and external factors governing growth has now been fairly definitely established by recent studies, Kraus and Kraybill (13), Murneck (29), Klebs (14), Pearsall (32), Garner & Allard (6). The adjustment of conditions in field tests, however, necessarily presents difficulties not encountered in control cultures. In the latter the variable factor is the nutrient solution or substrate, while in the former it is height of the plant, relatively speaking.

The problem then is, under what conditions are the results reported here reconcilable with those of other workers? Kraus & Kraybill (13) working with the tomato, came to this conclusion: "If moisture, nitrates, and carbohydrates all are abundant, these would be utilized in rapid vegetative extension, with little tendency toward the formation of specialized reproductive parts, or the storing up of large quantities of carbohydrates, as long as growth was active". This poorly reproductive and richly vegetative condition in unpruned tomato plants as discussed in the general review of this study, was reported by McKillican (22), Munro (25), MacKenzie (19), Reed (34) and has been

TABLE VI.
Average Weight as an Index of Size of Fruit.
Weight given in ounces.

Treatment and Truss Number		Bonny Best			Alacrity		
		Total crop	Ripe	Green	Total crop	Ripe	Green
"Stopped" at first truss	1	3.5	3.5	3.5	1.8	1.8	1.8
"Stopped" at second truss	1	4.0	4.6	2.9	2.5	3.0	2.0
	2	3.1	3.7	2.9	2.2	2.1	2.4
"Stopped" at third truss	1	3.4	3.9	2.6	2.4	3.0	1.8
	2	3.8	5.5	3.3	2.1	2.4	2.1
	3	2.7	1.5	2.8	1.9	1.3	1.9
"Non-stopped"	1	3.4	3.9	2.4	2.6	2.9	2.1
	2	2.8	4.7	2.4	2.5	4.0	2.3
	3	1.7	2.5	1.7	2.3	2.6	2.3
	4	1.1	—	1.1	1.2	—	1.2
	5	1.0	—	1.0	1.2	—	1.2

noted by the writer. The practice of limiting the vegetative extension of the tomato plant to one or two stems was, therefore, adopted as bringing about a more fruitful condition.

By restricting the growth of the plants still more, as in the present study, an even more harmonious relation between factors governing growth and reproduction was obtained. One cannot examine Table II without arriving at the conclusion that the capacity for photosynthesis and rapidity of fruit development was enhanced by the type of growth control applied to lots II in both varieties.

While no microchemical or chemical analyses were made it may be assumed that in these plants a carbohydrate-nitrogen ratio similar to that of the reproductive and vegetative class proposed by Kraus & Kraybill (13) existed. In fact, from the results obtained and presented in Table II, the capacity for fruit development varied but little in lots II, III and IV.

General effects of pruning such as lessening the carbohydrate material by pruning as suggested by Kraus (12) cannot with fairness be applied to this study. For instance, the apical and subsequently developing lateral growing points were removed before the contribution of carbon synthates from their leaves could be considered of much consequence. Rather was the adopted system of "stopping" growth instrumental in preventing the utilization of carbohydrates for vegetative extension by forcing them into channels leading to fruit formation.

Whipple & Schermerhorn (44) in discussing the effect of nipping off the top of the plant, say, "a plant so treated expends its energies in developing the fruit already set rather than in making more growth and forming more fruit".

From studies on *Sempervivum Funkii* and *S. albidum*, Klebs (14), under the headings of: (a) the production of the condition of ripeness to flower and (b) the development of flower clusters and elongation of the axis, concluded that it is the balance of assimilation over dissimilation that furthers the development of these two stages. In the present study, assimilation was not interfered with while the process of dissimilation was overcome by preventing vegetative growth.

As pointed out by Kraus & Kraybill (13) a relatively high carbohydrate content may cause excessive abscission of blossoms. Lots 1 may be considered plants in which this phenomenon was operative, since their percents of blossoms which set fruits were much lower than those of other lots. It seems reasonable to suppose that carbohydrates would be manufactured in amounts considerably in excess of the nitrogenous or protein requirements of these plants since the demand of the latter for cell division would be small owing to the maturity of the leaves and absence of growing points.

Murneek (29) points out that the inhibitory effects of the fruit on vegetative development are manifold. Among these he mentions decrease in size of flower clusters and all floral organs, and decrease and cessation of further elongation of the stem. The writer, from fairly extensive experience with tomatoes

grown on fertile soils, in days of long sunlight, believes that the inhibitory effects are exercised on fruit development rather than the contrary. The following statement by Kraus (12) lends support to this contention: "thus if two plants are grown side by side under identical nutrient conditions, and the fruits are removed from one, and allowed to remain on another, the latter, unless the quantity of nitrogen is exceedingly high, elongates more and more slowly as the fruits accumulate and grow in size". It must be remembered that vegetative growth in the tomato is not restricted to elongation of the main stem or stems, but that side branches may appear from practically every leaf axil. From the base of each leaf stalk on these lateral growths further vegetative extension may take place—provided nitrates are not lacking.

When one considers also that each simple inflorescence (flower truss) in tomatoes terminates an axis of three leaves, Crane (4), from the axils of which side shoots appear almost simultaneously with the inflorescences, the chances of the flower trusses being supplied with sufficient carbohydrates, or of assimilation exceeding dissimilation, are only one to three, if growth is not interfered with.

In cases where nutrients are deficient for maximum growth, however, the inhibitory effects as reported by Murneek (29) seem quite reasonable. A lack of nitrates inhibits cell division owing to a deficiency of active protein elements presumably concerned with this phenomenon. Neither would nitrogen deficient plants present a healthy green color. As shown by Lutman (18a) loss of color in leaves means inactivated chloroplasts, so that plants exhibiting signs of nitrogen starvation can be neither vegetative nor reproductive. The question of inactivated chloroplasts seems to have been largely overlooked by many investigators in determining the factors inhibiting the storage of carbohydrates.

The data obtained on the effects of pruning on blossoms differentiation and fruit setting clearly indicate the danger of drawing generalized conclusions from single experiments. Definite statements are withheld but the evidence presented in Table IV indicates that the set of fruit on the first truss influenced the set of fruit on the second and subsequent trusses on the Alacrity variety. Likewise it is equally apparent that no such influence was operating in the Bonny Best variety. As far as the writer is aware, such a varietal difference has not been pointed out before.

In an earlier paragraph, the effect of pruning on flower bud differentiation was discussed. In that connection evidence of specific varietal behavior was obtained in that the capacity for flower bud differentiation seemed to be increased by severe checking of growth in the Alacrity, a condition not apparent in the Bonny Best variety.

That size of fruit in the tomato is dependent upon proper fertilization and is an indication of the relative number of seeds maturing, or loculi containing seeds, has been confirmed by observations and counts during the present study. Crane (4) also reports that tomato fruits full of seeds were much larger than those without seeds. Concerning size of fruit in the apple, Heinicke (9) states "a large number of the apples which fall during the June drop are one-sided. The side containing seeds is larger than the side without seeds."

From the evidence, therefore, it would be unwise to attach particular significance to average weight of fruits with relation to the effects of pruning in the tomato. It would seem that proper pollination and degree of self-compatibility were influences of much consequence, especially from the standpoint of the commercial grower.

In conclusion, it seems imperative to point out that, while the figures obtained from the different lots of plants are comparable and indicate their behavior under similar planting distances and other environmental factors, the total yields do not represent the full capacity of the plants. Especially does this apply to lots III and IV, where undue shading occurred, owing to the close proximity of the plants to each other. In these lots less leaf surface was actually concerned in photosynthetic activity than in lots II which is suggested to account in part, at least, for the higher yield from the latter.

Conclusions

In regions where tomatoes make vigorous vegetative growth, and the length of the growing season is the limiting factor in the production of ripe fruit, special systems of culture are necessary to hasten ripening.

It has been conclusively demonstrated that by staking tomatoes and limiting growth to

one or two stems, the proportion of the crop which ripened was increased.

Furthermore, under climatic conditions similar to those obtaining at Indian Head, the most satisfactory crop from the standpoint of size and early maturity of fruit will be obtained from plants "stopped" after the differentiation of the third flower truss.

While "stopping" growth after the second flower truss had differentiated was demonstrated as resulting in a greater number and weight of ripe fruit there was a reduction in the total crop harvested.

On the other hand, the fruit produced on trusses beyond the third was of inferior quality and size, and may be considered wasted energy on the part of the plants.

Summary

Groups of tomato plants of the Alacrity and Bonny Best varieties "stopped" at the first, second, and third trusses of blossoms, and other groups "non-stopped" were compared with respect to earliness of ripening of fruit, amount and percent of fruit ripe, total yield of fruit, relation of set of fruit on one truss to that on another, flower differentiation and development, and average size of fruit.

The first ripe fruits were harvested from the lots "stopped" at the first truss in both varieties, three days before any had ripened on the other lots—with one exception—See Table I.

Lots II in both varieties "stopped" at the second truss, produced a larger number and a greater weight of ripe fruit in a given time. This would indicate better conditions for carbohydrate assimilation.

The percent of the crop which ripened on the first trusses of each lot in both varieties did not vary greatly.

Pruning reduced the total yield in proportion to its severity.

Great stability with respect to number of blossoms per truss, and set of fruit per truss, was exhibited by the Bonny Best variety.

Evidently the number of blossoms developed on the first truss of the Alacrity variety exerts an inhibitory effect on the number of blossoms differentiated on subsequent trusses.

There was some evidence that "stopping" growth at the first truss enhanced flower-bud differentiation in Alacrity—see "Number of blossoms" column, Table IV.

The relative size of fruit in the tomato is influenced by proper pollination and seed development as well as by pruning and nutritional methods adopted.

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A Tentative Method for Determining the Relative Injury of Calcium Arsenates to Foliage.

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Introduction

Observations made during several years have led us to consider that the official method of the Association of Agricultural Chemists for the determination of water-soluble arsenic in calcium arsenate, did not always give results indicating the relative safety of calcium arsenate when applied to foliage. A few years ago opportunity arose to study this point, and also to work on other methods of laboratory determinations, and the following article is an account of, first, a few cases where the official method failed to give satisfactory results, and second, a method of analysis which did give satisfactory results, with the materials under our observation.

Observations on Calcium Arsenate

In 1924 a considerable amount of arsenical burning was noted in many orchards treated with Bordeaux dust containing calcium arsenate. For the purpose of this article only those orchards treated with dusts of the following composition are considered; 12% dehydrated copper sulphate, 8% calcium arsenate, and 80% hydrated lime. A survey of the district covering numerous orchards revealed the fact that orchardists using this mixture were employing calcium arsenates almost exclusively of four different brands which are designated here as A, B, C, and D. Further, it was noted that the injury complained of was confined entirely to orchards where one particular brand of calcium arsenate had been used, which we will denote as A, and that no injuries could be found in orchards to which the brands B, C, and D had been employed.

We had under experiment an apple orchard of the variety Stark, which is rather susceptible to arsenical injury. Among the experimental plots in this orchard were two (in duplicate); to one had been applied Bordeaux dust containing 8% of calcium arsenate of brand A, and to the other, Bordeaux dust containing 8% calcium arsenate brand B. Burning developed on the plots treated with brand A to such a degree that after three applications further treatment was discontinued, while the plots treated with brand B remained normal and received four applications.

We had also under experiment an area of potatoes, each plot of which was dusted four times. The following table shows the materials used, and the results obtained.

TABLE I.

Plot	Material used.	Results
1.	Calcium arsenate B	Normal
2.	Calcium arsenate B, 20%, hydrated lime 80%	"
3.	" " B, 10% " " 90%	
4.	" " B, 20% talc 80%	..
5.	" " B, 10% " 90%	..
6	Calcium arsenate A	Very serious burning
7.	Calcium arsenate A, 20% hydrated lime 80%	Moderate burning.
8.	" " A, 10% " " 90%	" "
9.	" " A, 20% talc 80%	Serious burning.
10.	" " A, 10% " 90%	" "
11.	Calcium arsenate B, 20%, hydrated lime 65% dehydrated copper sulphate 15%	Normal
12.	Calcium arsenate A, 20%, hydrated lime 65% dehydrated copper sulphate 15%	Slight burning.

TABLE II.

Sample.	Water-soluble As_2O_5, as determined by official method p.c.	*Soluble As_2O_5 by tentative method p.c.	Total As_2O_5 p.c.
Calcium arsenate A, No. 1.	0.33	16.25	41.08
" " " No. 2.	0.52	15.63	43.30
" " " No. 3.	0.40	15.00	41.36
" " " No. 4.	0.35	15.63	41.54
" " " No. 5.	0.42	16.25	43.09
" " " No. 6.	0.38	15.00	44.48
" " " No. 7.	0.42	10.00	44.41
Calcium arsenate B, No. 1.	2.00	2.50	42.51
" " " No. 2.	1.49	2.50	43.79
" " " No. 3.	1.96	2.50	43.64
" " " No. 4.	2.13	3.13	43.49
" " " No. 5.	2.24	3.13	43.76
" " " No. 6.	1.59	2.50	46.15
" " " No. 7.	2.50	2.50	45.40

* See foot-note

From this table it will be seen that, whereas calcium arsenate B caused no foliage injuries, calcium arsenate A caused injuries in every case but varying in severity according to the mixture used.

From the foregoing it is apparent that there was a great difference in the effect upon foliage between calcium arsenate A and calcium arsenates B, C, and D (with more direct evidence concerning A and B).

The following table shows the total arsenic oxide (As_2O_5) content, and the water soluble arsenic oxide, in seven samples each of calcium arsenate A and calcium arsenate B, determined by official methods, and also the soluble arsenic oxide as determined by our tentative method.* Both calcium arsenates contained only traces of arsenious oxide, (As_2O_3) or other impurities.

If the water soluble arsenic oxide content as determined by the official methods were a correct criterion of the relative toxicity of these two calcium arsenates to foliage, then calcium arsenate B would cause more burning than calcium arsenate A, as will be seen from Table II. Field results, however, showed just the opposite. A perusal of the results of our tentative method however, indicates that in this case the percentages of soluble arsenic obtained would be a criterion of the relative toxicity of the two materials to foliage.

* The tentative method used here differs from the one finally adopted and described later in that much less calcium arsenate was used per given volume of water. This gives higher results, though the comparison is the same, than the method finally adopted as being more convenient.

Following this, samples of the 12—8—80 Bordeaux dust were collected from numerous orchardists and the soluble arsenic oxide determined by our tentative method. Samples of Bordeaux dust taken from consignments which had in part been applied to orchards and had caused burning, when analyzed showed soluble arsenic oxide similar to the results recorded above for calcium arsenate A. A few showed higher results and these orchards were severely burned; the orchard most seriously injured had been treated with a dust which gave 26.25% soluble arsenic oxide, the highest obtained from any analyzed in the investigation. Later work showed that Bordeaux dusts containing calcium arsenates C and D did not show similar amounts of soluble arsenic, the results being similar to that of B.

In 1925, several brands of calcium arsenate were tested both by the official methods and by our tentative method. A calcium arsenate, designated brand E, was extensively used for spraying and dusting. Analyses of several samples of this brand by our tentative method yielded high water soluble arsenic results. Following official methods of water soluble arsenic oxide determinations different samples of this brand E varied considerably, but the analytical results obtained were very similar to those of other brands of calcium arsenate which did not give high results following our tentative method. The effect on the foliage of this brand E was carefully noted in the orchards to which it was applied, and while the results were not as clear cut as in the previous year, since

a wet spring with a very bad scab outbreak complicated matters considerably, still there was no doubt in our minds that injuries were being produced in these orchards which were not present in orchards treated with other calcium arsenates.

The following table shows the soluble arsenic oxide determinations by our tentative method following the procedure we finally considered most convenient. Samples F and G are additional brands not previously mentioned, brand G being extensively used in orchards in 1926 with no trace of injury.

TABLE III.

Sample.			Per cent Soluble arsenic oxide.
Calcium	arsenate	A	3.23
"	"	B	Less than 0.1.
"	"	D	Less than 0.1.
"	"	E	1.90
"	"	F	0.20
"	"	G	Less than 0.1.

From the preceding data we conclude that as a measure of relative toxicity to foliage, the results obtained from official water-soluble arsenic oxide determinations of calcium arsenates may in some cases be misleading; this applying particularly to the use of calcium arsenate in Bordeaux but also evidently applying to calcium arsenate used alone or in mixtures of talc or hydrated lime. We also conclude that the method of analysis we propose is indicative of the relative toxicity of calcium arsenates to foliage, at least in the combinations mentioned above and with the particular materials handled by us.

Tentative Method of Soluble Arsenic Oxide Determination

Three grams of crystal copper sulphate are dissolved in about 450 c.c. of water and to this is added, with vigorous shaking, 10 grams of fresh high-calcium hydrated lime. One gram of the calcium arsenate under examination is then added, the volume made up to 500 c.c. and the flask thoroughly agitated. Carbon dioxide is then aspirated through the solution at a rate sufficient to keep the contents of the flask in agitation. (It is assumed that the calcium arsenate contains about 40% As_2O_5. If it does not then the amount of calcium arsenate taken should be such as to give 0.40 grams As_2O_5.) At fifteen minute intervals from 15 c.c. to 20 c.c. are removed from the flask and filtered. 10 c.c. aliquots of each of these filtrates is then tested for As_2O_5. The above procedure should be continued for about two and one-half hours. It is convenient to determine the As_2O_5 in the various 10 c.c. filtered aliquots by the Gutzeit method as described in Scott. The arsenic oxide found in each of the aliquots should be calculated on the basis of percentage As_2O_5 on the original one gram sample of calcium arsenate contained in the 500 cubic centimeters of solution.

Assuming the calcium arsenate to be of what we consider a satisfactory type, every test will yield practically no As_2O_5. The percentage of As_2O_5 in what we consider good brands of calcium arsenate will not exceed, say from 0.1% to 0.3% As_2O_5, though in many cases the amount found will be absolutely nil or less than 0.1%. In a calcium arsenate of what we consider an undesirable type the results are entirely different. Something after the type of the following is found:—the first two or three 10 c.c. aliquots will generally give low amounts of As_2O_5 but the successive 10 c.c. aliquots will give more and the calculated percentage may be as high as 2 or 3, after which the last few aliquots will generally decline and again only show low amounts. This rise and fall necessitates the taking of aliquots every fifteen minutes. With some calcium arsenates a peak is reached at some particular period and unless samples are taken every fifteen minutes this maximum is liable to be passed. The highest amount found is taken to represent the soluble arsenic oxide.

It may be mentioned that instead of CO_2 similar results will be obtained if air is used, only in this case several days are required in the test.

Studies in Tomato Streak.*

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During the fall of 1924 and the spring of 1925, several severe outbreaks of tomato streak occurred in greenhouses at Vineland, Ontario. In one particular case the crop was practically a complete loss. This laboratory therefore became interested, in so far as time would permit, in a preliminary study of this disease. We are especially indebted to Mr. Merle Fretz, Vineland, for his co-operation and kindness in loaning the use of his commercial greenhouses for experimental purposes. The writer wishes to express to Mr. Merle Fretz and Mr. Wm. Fretz, his appreciation for their valuable co-operation and assistance with the investigations.

From inspections made in many greenhouses the writer has repeatedly noted, not only the great variety of "streak" symptoms encountered, but also the many apparent inconsistencies as to manner of spread, predisposing factors, etc. In greenhouse A., which is one of a range of four, during the last two years streak has been present to a considerable extent and most severe always in the south east section of the house. The first cases were invariably found in that quarter, from where it seems to have spread to three-quarters of the greenhouse. In other words here is an observation that suggests a connection with the soil and which points to a fairly rapid spread of the disease. In greenhouse B., streak appeared here and there throughout the greenhouse (19 plants) with three the greatest number together at any one place. In this case streak did not spread to more than five additional plants. This case appears to be quite different from the above. In A, there appears to have been one point from which spread started, while in B, there were many centres of possible spread. Yet in B there was practically no spread, while in A it was considerable.

The writer at the present time is unable to account for such differences in spread. However from observational, as well as experimental evidence, he is strongly of the opinion that greenhouse environment is a most important factor in this connection.

From observations made during the last three crops in the greenhouses of Mr. Merle Fretz, the necrotic areas as found in streaked leaves may be of two types. In the west greenhouse most of the "streaked" plants were of the normal type, with black necrotic areas on stem, leaves and sometimes fruit. (Plate 1. Fig. 1). Under conditions favorable to streak, these plants usually became partially or wholly defoliated, stunted and practically worthless. In this same greenhouse there have been (in the last two crops) a half dozen or more plants which showed necrotic areas on leaves and fruit, but in so far as the leaves were concerned, the necrotic areas were not black in color, but rather greyish-white. (Plate 1, Fig. 2.). The tomato plants having this type of necrosis never became affected to the same degree as the previously described type. The necrotic areas did not spread over the leaf surface to the same extent with the result that the leaves very seldom dried up and died. Whether these are two distinct types, or the apparent difference in symptoms is merely a difference in degree of the same type, remains to be ascertained. No attempt has, as yet, been made to verify this by cross inoculations.

Although in nearly all cases of streak, mosaic symptoms are likewise present as a mottling of the tip foliage at least, we have observed some half dozen plants at different times, growing alongside normal "streak" plants which showed no signs whatever of mosaic mottling, before or after the streak lesions appeared. This is an interesting observation. The lack of mosaic symptoms can hardly be explained in these cases on the basis of temperature-masking, since under the same growing conditions and at the same time, other streak plants showed the mosaic symptoms.

Symptoms

Although the disease is generally first noticed on tomato plants about the time the first truss is forming, it may occur before

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† Mr. Champlain Perault, who was temporarily employed at this laboratory in the summer of 1926, assisted with the early series of inoculations.

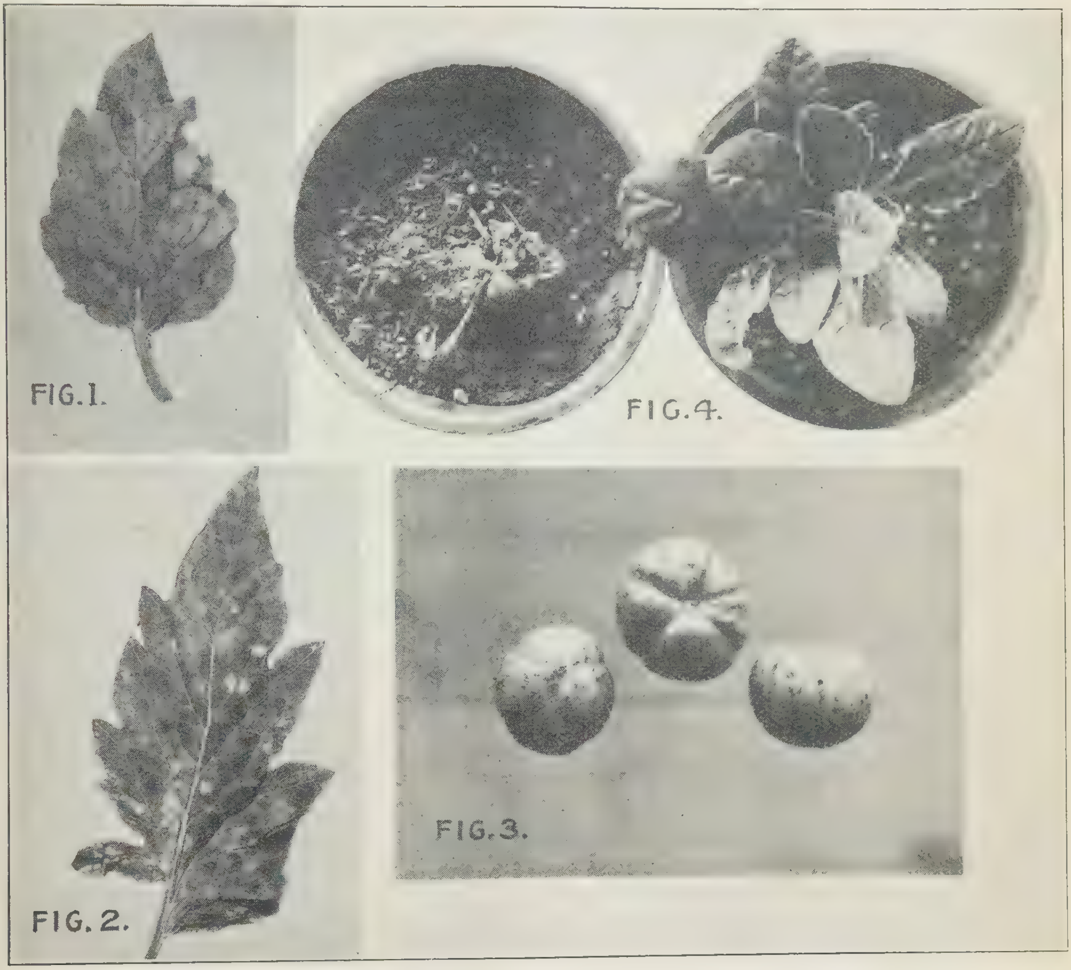

Fig. 1. Tomato leaf showing the normal black necrotic areas of streak.

Fig. 2. Tomato leaf showing greyish-white necrotic areas of streak.

Fig. 3. Fruits from "streak" tomato plants showing the sunken and raised necrotic spots.

Fig. 4. Left—a necrotic shoot which died shortly after appearing above ground.
Right—a "speckled mosaic" shoot of same age. Both these shoots (see exp. 13) came from plants which had been previously killed by tomato streak, but which later sent up the shoots, as illustrated, from below ground portions of the crown. The "speckled mosaic" grew very rapidly for a time, as can be seen by the photograph, but in time it also became necrotic and died.

or after this stage of growth. Streak has been found on plants from six to ten inches in height, as well as on plants that showed no signs of the disease until about the time of the formation of the fourth truss.

The disease affects the leaves, stems and fruit. It is usually first found on the younger terminal leaves, or on the fruit. The writer has, as yet, observed very few cases where the lesions were first produced on the stem. Very often, however, the first signs of the disease are brown, slightly raised, or sunken irregular spots on the fruit (Plate 1, Fig. 3). Later necrotic areas may or may not be present on leaves and stem. Generally however the first definite symptoms are found on the leaves as brownish to black irregular necrotic spots (Plate 1, Fig. 1). These may be few or numerous depending upon the severity of the diseases. Likewise, black necrotic streaks are generally found on the stem, though these may, for the most part, be lacking. When conditions are favorable for the disease, affected leaves wilt, dry up and die. Under

certain conditions "streaked" leaves may show very little signs of wilting and may function with some degree of efficiency, till the death of the plant, as a whole. If a "streak" plant is not killed outright by the disease, the new upper growth will generally be mottled and spindling. This new growth may or may not become necrotic.

The necrotic areas on a plant are generally confined to a region about twelve to eighteen inches in extent, two-thirds up the plant. Although the writer has never seen necrotic areas on the lower five or six leaves, necrotic "streaks" have been observed on the stem from the ground-line up. Also necrosis is sometimes found from the first leaves affected right up to the extreme terminal growth, with all new growth becoming in turn necrotic. In other cases new growth may be mottled only, with no signs of necrosis.

The brown lesions on the fruit are for the most part irregular, greasy and sunken, though both raised and sunken spots may be found on the same fruit. (Plate 1, Fig. 3).

Part I.

It has been shown by Howitt and Stone(2) and others, that soft, succulent growth is a predisposing factor with this disease. The first experimental endeavour, from the standpoint of prevention, was therefore to attempt to have an even regular growth, so as to avoid a too rapid growth at one stage with its resultant soft, succulent tissue, followed by a necessary checking up of the growth rate at a later period. It was also desired to have the plants free from mosaic, as the work of Gardner (4) and later Vanterpool (5) has shown that streak is a virus disease. To this end the seed was sterilized, fresh soil was used and the plants were grown in one of the greenhouses in plots as far away from mosaic plants as possible. It would have been preferable if these could have been grown in a greenhouse or cold frame distant from all solanaceous crops, but at this time it was impossible. However the plants were very healthy, the percentage of mosaic plants being much less than Mr. Fretz had formerly had. Before transplanting the plants into the greenhouse, the soil was completely turned over to about eighteen to twenty (18-20″) inches and a heavy application of manure worked in. The soil was therefore fairly rich.

Mr. Fretz so manipulated ventilation, water and heat that as steady a growth as possible might result. No nitrate was added, but when the plants were forming the second truss a light mulch was added to the soil. Another mulch was added three weeks later. In so far as possible, the temperature was kept around 70°F. in the daytime, and not below 50°F. at night. The result was that the plants grew very evenly, steadily, yet fairly rapidly and the resulting crop was the best that Mr. Fretz ever had. In this greenhouse not one case of streak showed up, and although thirty-five plants were inoculated with streak material by means of pin pricks, rubbing of leaves, and insertion of macerated streak tissue in slits in the stem, *in no single case did streak result.* These plants were growing fairly rapidly at the time, and were forming the 3rd and 4th trusses.

Why did streak not appear in this greenhouse? Why did not some cases appear as a result of inoculation, especially since the writer on many other occasions has had one hundred per cent infection of healthy tomato plants by inoculations with streak material? Are the negative results to be put down to greenhouse management? It hardly seems possible, and yet, later, one hundred per cent positive results were obtained from inoculations with streak material from the same source.

In another greenhouse some twenty-five "streaked" plants showed up, but the spread was nil, due most likely to careful greenhouse management.

In this connection it was desirous to obtain information concerning the following points relating to control. Once a plant has become "streaked" is it advisable to (1) dig it out, (2) add fertilizer and moisture to increase its growth rate and attempt to grow it out of the disease or (3) to try and gradually slow up the growth and harden the plant.

Experiment 1.

Twenty-four tomato plants were inoculated with streak and were then treated as follows:

On October 11th, all plants were inoculated.

Six plants received a heavy application of manure water the day they were inoculated (Oct. 11) and this was repeated on two other occasions, the 13th and 18th respectively. These same plants received two heavy applications of nitrate of soda, so much so that they showed signs of wilting.

On October 21st, all six plants were definite and severe streak, so much so that on the 24th, the plants were useless and were "dug up." This experiment therefore bears out the findings of Howitt and Stone(2) tthat too

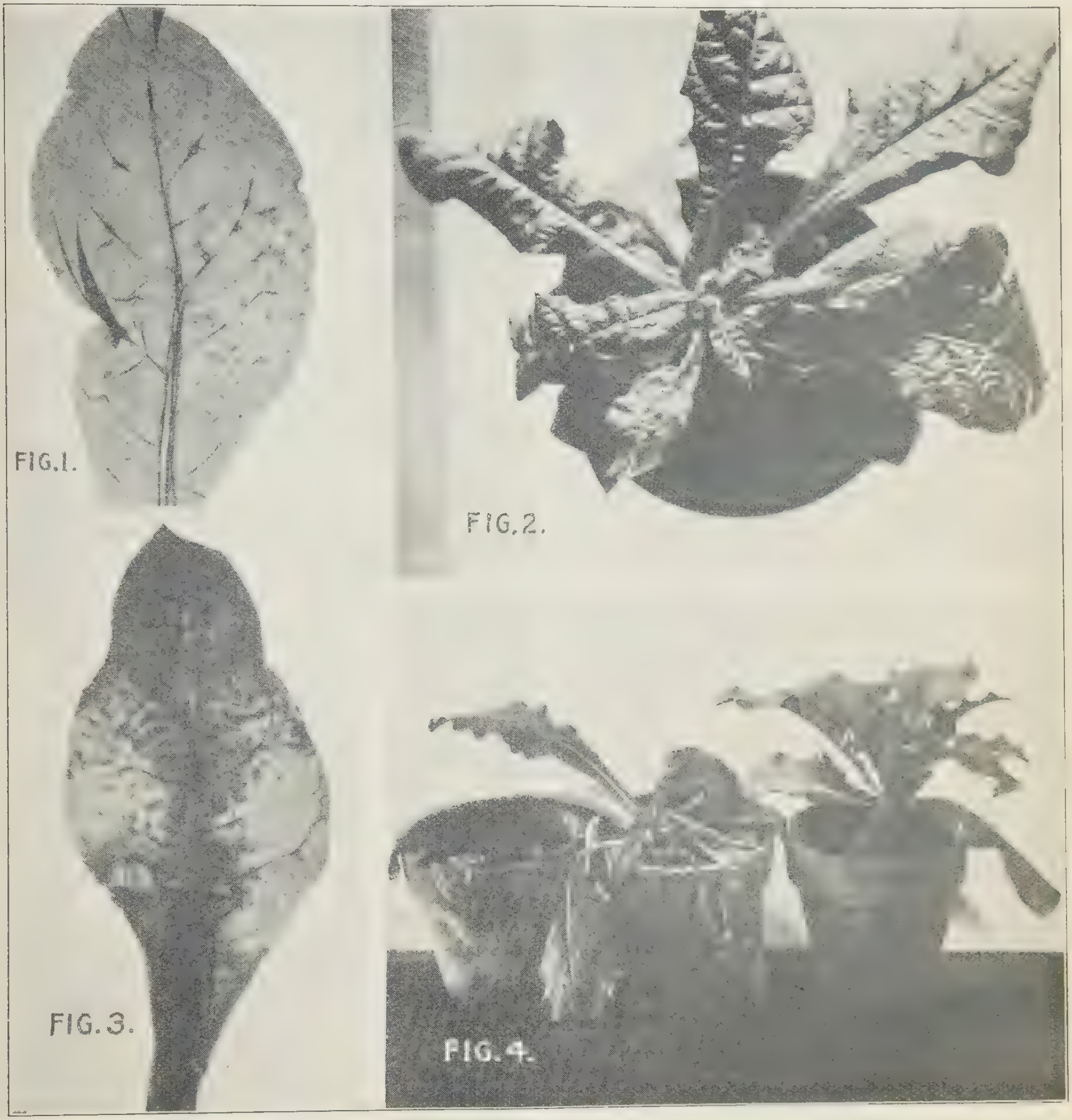

Fig. 1. Tobacco leaf showing necrotic areas along midrib, main veins, and on leaf blade tissue.

Fig. 2. Tobacco plant inoculated with tomato streak, showing several necrotic and dried up leaves in centre of crown.

Fig. 3. Tobacco leaf showing necrotic areas along main vein, and leaf blade tissue.

Fig. 4. Left—Plant killed by tomato streak. Middle—Plant partially killed by tomato streak. Right—Healthy plant.

liberal applications of nitrate and nitrogenous manures are to be avoided.

Six other plants were inoculated and left untouched. These showed streak symptoms on October 24th but not so severe as in the previous case. This of course again bears out the fact that plants which are abnormally forced suffer most severely from this disease. These six plants were likewise dug up in order to see if this would keep down spread. It was found that three plants in the adjacent row contracted the disease. It did not spread further. It is interesting to note that the latter six plants were three days longer in showing the streak symptoms, than the former. The nitrogenous manures therefore not only brought on a much more severe type of streak, but as well shortened the incubation period by three days.

The other twelve plants were scattered throughout the green house. These streak plants were very carefully handled; the pruning was done in such a manner that no juice came in contact with the hand, at any time.

This was affected by holding the shoot to be pruned about one inch from the desired point of severance and then by giving it a quick pull, the shoot was broken off cleanly with no contact whatever with the cut surface. By being careful therefore, with pruning and pollinating in only three cases did the disease spread to the neighboring plant.

EXPERIMENT 2.

In order to ascertain whether or not streak may be spread by the grower during pruning operations especially when pinching off shoots from "streaked" plants and then passing directly to pinching off shoots from healthy plants, Mr. Merle Fretz very kindly consented to start in at plant No. 1, in the southeast corner and then systematically to take each plant in order. In so doing Mr. Fretz passed directly from twenty-five "streak" plants to the same number of health plants and yet in no single case did streak spread.

However the writer has seen other cases here and elsewhere where apparently definite spread did occur from pruning operations. Such inconsistencies may be due, in part at least, to differences in greenhouse management.

Our investigations indicate that "streak" of tomatoes need not be a serious disease in a well managed greenhouse. In any case we have had very satisfactory control of this disease during the last three successive crops in the commercial greenhouses of Mr. Merle Fretz.

From the investigations carried out by the Dominion Laboratory of Plant Pathology at St. Catharines, the following recommendations relating to control, are given.

1. Since streak is of the "mosaic" type of disease it is essential that the tomato seed-bed, plant-bed, etc., should be distant from old tomato and potato crops.

2. Practice strict sanitary measures in the seed-bed, plant-bed, or glass house; do not allow weeds in close proximity to tomatoes since recent investigations have shown that they (weeds) may harbour mosaic and related diseases (streak?).

3. Set out healthy plants only.

4. The soil for growing of greenhouse tomatoes should be well drained, and contain abundant humus and general fertility so that there will be little need for the addition of commercial fertilizers.

5. Temperature as near 70-75°F. as possible in the day time; not below 50°F. at night.

6. Avoid too much nitrate or too heavy and too frequent mulchings. Mulching should be delayed until the second and third trusses of fruit have set. We have had our best results from a light mulching applied when the second truss had set, followed by another heavier mulching, ten to fourteen days later.

7. Acid phosphate is to be recommended.

8. Practice strict adherence to regularity in watering, lessening or increasing the amount according to weather conditions.

9. Avoid all measures which tend to force the plants into soft, succulent growth.

10. Above all, endeavour to manipulate greenhouse environment so as to encourage an even, steady, regular growth. Avoid "forcing" and then later "checking" the plants.

Whether "streak" is a "virus" disease, as now understood by this term, or merely a physiological phenomenon associated with abnormal metabolism, one fact stands out clearly, that it is not of a simple nature. That is, no single factor is able to bring about the disease consistently, but evidently a combination of factors is necessary. Just what this combination is, remains to be ascertained. However, our observations and experimental work have led us to the conclusion that greenhouse environment (soil, temperature, humidity, ventilation) is one of the most important factors, from the standpoint of control. This has been demonstrated on more than one ocsion. For instance in the experiment already mentioned, where no "streak" resulted when thirty-five tomato plants were inoculated with tomato "streak" material under one set of greenhouse conditions, yet later under another set of conditions many cases of "streak" did result from inoculations with "streak material" from the same source, is a case in point.

Part II.

There are to-day three views held as to the etiology of streak.

(1) That it is caused by bacteria—

Paine & Bewley (4), 1919, published an account of experiments which showed that *Bacillus lathyri* (Mans & Taubenhaus) was the cause of a disease of tomato in England which had symptoms identical with streak. Howitt and Stone (2), Vanterpool (5) and others and the writer have all isolated yellow bacteria agreeing with the description of *Bacillus lathyri*, but in no case have positive results been obtained from inoculation.

(2) That it is a virus disease. A type of mosaic.—

Max W. Gardner (1) considers severe streak of Bonny Best to be a mosaic disease, and further says "the mosaic nature of the disease was further verified by successful inocu-

lation of healthy tomato seedlings with the juice of a young fruit by J. B. Kendrick and by numerous cultural tests which proved the internal fruit lesions to be free from bacteria." So far as the writer is aware this is the first definite record of a verification of the mosaic nature of streak.

(3) That it is non-parasitic and is the result of malnutrition and improper environmental conditions in the greenhouse.

In phytopathology, May 1926, Vanterpool published a paper on Streak of Tomato in Quebec in which he verifies Gardner (1) in that the "streak" disease of tomatoes is of the "filterable virus" type. He, however, goes further and says "that all evidence indicates that these combined viruses (potato mosaic and tomato mosaic) are the true cause of the trouble." Recently James Johnson (3) has pointed out that juice of healthy potato combined with tobacco mosaic produced an extremely malignant type of disease with necrosis on various members of the solanaceae family. On the tomato it is often so virulent as to kill the entire plant. He has also demonstrated that the juices from healthy potato alone (especially Rural New Yorker) produce mosaic symptoms on tobacco with necrotic areas, in many cases (streak).

Experiments

The following experiments were projected by the writer in the greenhouse of (1) Mr. Merle Fretz, Vineland, (2) the laboratory greenhouses, and (3) in field experiments at various places throughout the district. The details of these experiments will not be given, since it is considered that all due precaution was used in the transfers, etc. Inoculations were generally effected by needle punctures, or direct insertion of macerated tissue.

Experiment 1.

To verify the findings of Gardner (1) and Vanterpool (5) that streak is a "virus" disease the following inoculations were carried out in the greenhouse of Mr. Merle Fretz, Vineland:

No. of plants	Method of Inoculation	Source of Inoculum	No of plants Mosaic	No. Streak
10	Rubbing of tip leaves	Tomato Streak A.		none
10	Insertion of macerated leaf tissue	Tomato Streak A.	10	none
10	Insertion of macerated leaf tissue	Lower leaves (apparently healthy) of streak	10	none
10	Insertion of macerated leaf tissue and leaf rubbing.	Tomato mosaic shoestring type	10	none
10	Insertion in stem of macerated leaf tissue	Tomato Streak B.		none
5	Tomato mosaic and streak		5	none
500	Check plants		450	none

Since the five hundred check plants all became more or less mottled toward the end of the experiment the mosaic symptoms occurring on the inoculated plants were not likely the direct result of inoculation.

No streak symptoms whatever occurred.

Experiment 2.

Further inoculations were tried out in the greenhouse of Mr. Wm. Fretz, as follows:

No. of plants	Method of Inoculation	Source of Inoculum	Mosaic	Streak	No positive results
6	Insertion	Streak material A.	6		
9	Insertion	Streak B.	6	2	1
3	Rubbing	Streak B.	3		
100	Check plants.				

NOTE: Streak A. and Streak B. designate two different sources of streak material.

Experiment 3.

On July 30, 1926, inoculated by rubbing, twelve tomato plants that were growing outdoors and were making very poor growth and were accordingly not in a soft, succulent state.

No. of plants	Source of Inoculum	Streak	Remarks
5	Lower healthy leaves of plant	3	2 Yellow and definite mosaic
5	Definite streaked leaves	3	2 mosaic
3	Check plants	1	2 healthy

Experiment 4.

The following experiments were carried out in the Laboratory greenhouse and land at St. Catharines. Ten healthy tomato plants about ten inches high, outdoors, were inoculated with filtered juice and macerated tissue of streaked material, as follows:

Plant No.	Streak Inoculum	Date of Inoculation	Results
3	Filtered juice	June 22	Streak July 15
3	Macerated tissue	June 22	Streak July 15
4	Pulp	June 22	Streak July 15
9	Check plants		All showed signs of mosaic by July 8th, but no streak.

Experiment 5.

To ascertain if all parts of a plant carry the infective principle the following experiment was carried out. Inoculations were effected by insertion of macerated tissue in stem.

Date	No. of plants	Material for Inoculum	Date Streak appeared	Incubation period	Streak %
Aug. 4	10*	Crushed leaves	Aug. 16	12 days	100
Aug. 4	10*	Stems, petioles	Aug. 19	15 days	100
Aug. 4	20*	Roots macerated	Aug. 19	15 days	100

*NOTE: Plants when inoculated were about to mature their first fruit, and were therefore of considerable size. It is interesting to note therefore that in every case streak first appeared on the fruit four or five days, at least, before appearing on stem or leaves. In some cases the fruit alone was affected.

The experiments outlined above are a good example of the inconsistencies which the writer has encountered at various times with streak inoculation experiments. In experiment 1, not one case resulted from fifty-five inoculations. Yet in four other experiments practically one hundred per cent positive results were obtained from streak inoculations. In other cases the writer has had positive results from inoculating healthy tomato plants, with tomato mosaic alone, and even with juice from healthy tomato plants, as well as potato, and yet at other times negative results were obtained. In all cases the inoculations were effected in the same manner, and in some instances with the same material. The writer does not attempt, as yet, to explain such inconsistencies. However, these experiments have clearly demonstrated that "streak" of tomato, in Ontario, belongs to the "filterable virus" type of disease.

Plants	No.	Inoculation Date	Inoculation Height	Streak first appeared Date	Streak first appeared Height	Incubation period	Streak %
	1	Aug. 25	9 ins.	Sept. 5	12 ins.	11 days	
	2	" 25	9 "	" 5	13 "	11 "	
5	3	" 25	8 "	" 5	13 "	11 "	
	4	" 25	6 "	" 5	11.5 "	11 "	100
	5	" 25	9 "	" 15*	25 "	21 "	
	1	Sept. 1	11 "	Sept. 14	18 "	13 "	
	2	" 1	14 "	" 13	19 "	12 "	
5	3	" 1	13 "	" 13	18 "	12 "	
	4	" 1	11 "	" 20	17 "	19 "	100
	5	" 1	15 "	" 16	22 "	15 "	
	1	Sept. 8	19 "	Sept. 20	24 "	12 "	
	2	" 8	18 "	" 18	23 "	10 "	
5	3	" 8	22 "	" 22	30 "	14 "	
	4	" 8	23 "	" 20	31 "	12 "	100
	5	" 8	20 "	" 20	28 "	12 "	
	1	Sept. 15	23 "	Sept. 27	37 "	12 "	
	2	" 15	22 "	" 27	35 "	12 "	
5	3	" 15	27 "	" 27	39 "	12 "	
	4	" 15	24 "	" 22	32 "	7 "	100
	1	Sept. 29	32 "	Oct. 6	33 "	7 "	
	2	" 29	38 "	" 13	42 "	14 "	
5	3	" 29	33 "	" 13	34 "	14 "	
	4	" 29	38 "	" 17	44 "	18 "	100

Four plants were left as a check and remained healthy during the time of the experiment.

*This particular plant had all the earmarks, twelve days after inoculation, of a "streak" plant, but without the streak lesions. The foliage was peculiarly streak mottled and somewhat curled and the growth as a whole was spindling.

EXPERIMENT 6.

The following experiment was projected to ascertain if there is any particular stage in the growth of a tomato plant when it is more susceptible to streak than at any other time. This experiment was tried out under both greenhouse and field conditions at St. Catharines. The seedlings were set out at the same time and made a fairly rapid growth. When they were about nine to ten inches high the first series of inoculations were effected, and then at intervals of seven days the second, third, etc., series of inoculations were carried out, so that there was a difference of four weeks growth between the first and last inoculations. The height of the plants in inches is given at time of inoculation and when streak first appeared.

This same experiment was tried out with tomatoes growing under field conditions.

No. of plants	Inoculations Date		Height	Streak first appeared Date		Height	Incubation period	Streak %
1	Aug.	28	8 ins.	Sept.	9	9 ins.	12 days	
2	"	28	7 "	"	9	9 "	12 "	
3	"	28	8 "	"	9	10 "	12 "	100
4	"	28	8 "	"	9	7 "	12 "	
1	Sept.	3	8 "	Sept.	20	11 "	17 "	
2	"	3	9 "	"	15	11 "	12 "	
3	"	3	8 "	"	15	9 "	12 "	100
4	"	3	8.5 "	"	20	10 "	17 "	
1	Sept.	9	9.5 "	Sept.	27	11 "	18 "	
2	"	9	10 "	"	27	13 "	18 "	
3	"	9	10 "	"	20	11 "	11 "	100
4	"	9	9 "	"	27	11 "	18 "	
1	Sept.	15	11 "					
2	"	15	12 "	Oct.	6	21 "	21 "	
3	"	15	14 "	"	6	21 "	21 "	100
4	"	15	11 "	Sept.	27	12 "	12* "	
5	Check plants					healthy at end of experiment.		

*Incubation period in this case same as for younger plants.

The results in the greenhouse do not entirely correspond to those obtained in the field. In the greenhouse where the plants were growing rapidly the incubation period averaged around twelve to thirteen days while in the field it averaged fifteen days. In the greenhouse the incubation period was about the same, irrespective of the age of the plant, whereas in the field, the age of the plant appears to have had an appreciable effect on the incubation period as manifested by an incubation period of around twelve days in the case of the younger plants and a period of eighteen to twenty days in the case of the older plants. It is appreciated of course that the varying climatic conditions in the field influenced these results.

EXPERIMENT 8.

The following commercial varieties were grown in the greenhouse at St. Catharines and tested for susceptibility to streak.

No. of plants	Variety of Tomato	Date of Inoculation		Date Streak appeared		Incubation period
1	Sunrise	Sept.	8	Sept.	22	14 days
2	"	"	8	"	24	16 "
3	"	"	8	"	20	12 "
1	Chalk's Jewel	Sept.	8	Sept.	20	12 "
2	"	"	8	"	24	16 "
3	"	"	8	"	22	14 "
1	Earliana	Sept.	8	Sept.	20	12 "
2	"	"	8	"	20	12 "
3	"	"	8	"	22	14 "
1	Bonny Best	Sept.	8	Sept.	22	14 "
2	"	"	8	"	22	14 "
3	"	"	8	"	22	14 "
1	New Globe	Sept.	8	Sept.	20	12 "
2	"	"	8	"	20	12 "
3	"	"	8	"	20	12 "
1	Grand Rapids	Sept.	8	Sept.	20	12 "
2	"	"	8	"	24	16 "
3	"	"	8	"	24	16 "
1	Veal	Sept.	14	Sept.	24	10 "
2	"	"	14	"	27	13 "
3	"	"	14	"	27	13 "
4	"	"	14	"	24	10 "

All varieties tested took streak with equal readiness although the Earliana, Globe and Veal varieties showed symptoms slightly more severe than the other varieties. Also streak appeared on these varieties slightly in advance of the other varieties.

This experiment was duplicated under field conditions with similar results.

EXPERIMENT 9.

The following experiment was carried out to ascertain the effect of inoculating healthy tomato plants of the Bonny Best variety with juice from healthy tomato plants of the same and other varieties, as well as healthy tobacco and potato juices. All plants were inoculated at the same time on September 8th.

No. of plants	Inoculum	Appearance of Mosaic mottling	Appearance of Streak	Streak Incubation period	Remarks
1	Bonny Best	Sept. 21	Sept. 27	19 days	
2	" "	----	----	----	foliage of yellow color
3	" "	Sept. 22	Sept. 27	14 days	----
1	Globe	----	----	----	healthy
2	"	Sept. 22	Sept. 24	16 days	----
3	"	" 22	" 24	19 "	----
1	Sunrise	Sept. 22	----	----	----
2	"	" 27	----	----	----
3	"	" 27	----	----	----
1	Chalk's Jewel	Sept. 24	----	----	foliage slightly yellowish, with coarse yellowish green blotching.
2	"	" 24	----	----	
3	"	" 24	----	----	
1	Tobacco	Sept. 20	----	----	
2	"	" 22	----	----	
3	"	" 24	----	----	
1	Potato	Sept. 22		----	----
2	"	" 22	Sept. 24	16 days	----
3	"	" 24	" 27	19 "	----
4	"	----	" 19	11 "	----
5	"	----	" 20	12 "	----
6	"	----	" 20	12 "	----

It is very interesting to note that streak was obtained in some cases by inoculating tomato plants with juice from apparently healthy tomato plants. Streak was obtained when juice from Bonny Best and Globe varieties of tomatoes was used for inoculum. No streak was obtained when juice from healthy plants of Sunrise, or Chalks Jewel was used as inoculum, although with one variety, Sunrise, definite mosaic symptoms were obtained and with the other, Chalk's Jewel, a very peculiar yellowish-green blotching was obtained. These results however, are somewhat inconclusive since the plants were unprotected and therefore these inoculations should be tried again under more controlled conditions and in greater numbers. However it is interesting to note that all the plants were inoculated on the same day, September 8th, and that the streak symptoms began to show up at about the same time throughout the house, namely September 24-27th. This would appear to indicate that natural infection did not take place.

In order to verify Experiment 9, in so far as healthy potato juice is concerned twelve tomato plants that were protected from the time the seed was sown till after the experiment was completed, were inoculated under controlled conditions with fifty per cent positive results. In other words on three different occasions, under varying greenhouse environment streak has resulted from inoculating healthy tomato plants with the juice of healthy potato plants. Such experimental evidence warrants the conclusion that the juice from potato whether healthy, as this term now implies, or affected with mosaic or streak diseases, incites the streak disease in healthy tomatoes. This may mean that the potato plant naturally carries a latent virus, or else that it has in its juices (protoplasm) something that initiates or excites in the protoplasm of the tomato plant an abnormal metabolism that produces the characteristic "streak" symptoms. There is therefore no necessity of postulating a combination of viruses (potato mosaic and tomato mosaic) as the real

cause of streak, since potato juice itself is sufficient to cause this disease, as has been demonstrated here. It should be noted that the potatoes used in these experiments came from specially selected Government certified stock, and the plants obtained from these tubers have been absolutely healthy and very vigorous growers. There has been no indication whatever of the presence of any disease.

EXPERIMENT 10.

The following is an experiment to ascertain the effect when healthy tomato plants are inoculated with juice from mosaic tomato, mosaic tobacco and mosaic potato plants, singly and in combination. The tomato plants to be inoculated were protected by insect-proof cages in order that no undesirable infection might take place. These cages were not removed until the end of the experiment.

No. of plants		Inoculum	Date of Inoculation	Date Streak showed	Inoculation period
	1	Tomato mosaic	Sept. 14	Sept. 24	10 days
3	2	“ “	“ 14	“ 24	10 “
	3	“ “	“ 14	“ 24	10 “
	1	Tomato “ Potato “	“ 14	“ 24	10 “
3	2	Tomato “ Potato “	“ 14	“ 24	10 “
	3	Tomato “ Potato “	“ 14	“ 22	8 “
	1	Potato “	“ 9	“ 22	13 “
3	2	“ “	“ 9	“ 22	13 “
	3	“ “	9	“ 22	13 “
	1	Tobacco “ Tomato “	“ 14	“ 24	10 “
3	2	Tobacco “ Tomato “	“ 14	“ 24	10 “
	3	Tobacco “ Tomato “	” 14	“ 22	8 “
	1	Tobacco “	“ 9	“ 22	13 “
3	2	“ “	“ 9	“ 26	17 “
	3	“ “	“ 9	“ 27	18 “
	5	check plants remained healthy.			

The results as indicated here would seem to point out that in addition to potato juices, mosaic tomato and mosaic tobacco juices would likewise cause streak, particularly when this experiment was carried out under controlled conditions. However, another similar experiment under similar controlled conditions from the time the seed was sown until the experiment was completed has given negative results with mosaic tomato, and mosaic tobacco juices. At the present time therefore these results are inconclusive and need further experimentation.

The writer, of course, realizes that the material used for inoculum although coming from apparently mosaic plants, may have had latent streak virus present, but if so the streak symptoms were entirely absent. Moreover the tomato, potato, and tobacco plants from which leaves were taken for inoculation purposes, have now, November 1st, no signs whatever of streak.

EXPERIMENT 11.

This same experiment was tried out in the Fretz commercial greenhouse at Vineland, and outdoors at St. Catharines, Ontario, but the plants were not caged.

No. of plants	Inoculum	Date of Inoculation	Results
6	Potato mosaic	Oct. 11	6 plants streak on Oct. 22. The source of inoculum in this case was taken from a field of potatoes 50 per cent mosaic.
6	Tobacco mosaic	Oct. 11	6 plants mosaic.
6	Tomato streak	Oct. 11	6 plants streak on Oct. 22.
6	Potato streak	Oct. 11	6 plants streak on Oct. 22. 2 plants streak.
6	Tomato mosaic	Oct. 11	4 plants mosaic and stunted.
6	Potato & Tomato mosaics	Oct. 11	3 plants streak on Oct. 25. 3 plants mosaic.
6	Tomato streak	Oct. 11	6 plants streak on Oct. 24.

It is interesting to note that where either tomato streak or potato streak were used singly, as source of inoculum, one hundred per cent infection was obtained in eleven days. But where potato streak and tomato mosaic in combination, was used as source of inoculum, fifty per cent infection only was obtained and was delayed three days in showing up. This time negative results were obtained with tomato mosaic (with the exception of two plants) and tobacco mosaic.

One hundred check plants all showed definite mosaic mottling at the end of the experiment, so that the showing up of mosaic symptoms on the inoculated plants was not likely due to the inoculations. No streak whatever showed up in the one hundred check plants.

EXPERIMENT 12.

In the following experiment healthy plants were set outdoors and inoculated as follows, and one hundred check plants (healthy) of the same origin were healthy at end of the experiment.

Variety	No. of plants	Inoculum	Date of Inoculation	Streak appeared	Mosaic	Incubation period
Grand Rapids	1	Tobacco	Sept. 14	----	mosaic	
	2	mosaic	" 14	----	"	
	3		" 14	----	"	
	4		" 14	Sept. 30	----	16
Grand Rapids	1	Potato	" 14	Sept. 27	----	13
	2	mosaic	" 14	" 27	----	13
	3		" 14	" 30	----	16
	4		" 14	" 27	----	13
	1	Tomato &	" 14	Sept. 27	----	13
	2	Potato	" 14	" 24	----	10
	3	mosaics	" 14	" 27	----	13
	4		" 14	" 27	----	13
Grand Rapids	1	Tobacco &	" 14	----	mosaic	
	2	Tomato	" 14	----	"	
	3	mosaics	" 14	----	"	
	4		" 14	----	"	
Grand Rapids	1	Tomato	" 14	Sept. 27	----	13
	2	mosaic	" 14	" 27	----	13
	3		" 14	" 30	----	16
	4		" 14	----	----	
Grand Rapids	100	Check plants			healthy.	

It is interesting to note again that streak resulted from potato mosaic (singly) as well as potato mosaic and tomato mosaic in combination. Also that no streak resulted in the case of tobacco and tomato mosaic in combination. Streak likewise resulted from inoculating Grand Rapids with tomato mosaic (Veal variety).

It is important to note that streak has resulted consistently when potato juices (whether healthy, mosaic, or streak), tobacco streak juice, tomato streak juice, and potato streak juice have been used as inoculum.

EXPERIMENT 13.

In order to find out if tomato streak is transferable to tobacco the following experiment was carried out. Eight healthy tobacco plants were inoculated on September 8th, with following results. Twenty-five healthy tobacco plants were used as a check.

No. of plants	Date of appearance of Mosaic & Necrotic areas	% of Infection	Results
8	September 20-24	75	Mosaic symptoms with black necrotic areas appeared in 12 to 14 days, followed by complete break down of affected leaves*.
25	------	--	The check plants in all cases remained healthy throughout the experiment.

*NOTE: It is very interesting to note that two of the tobacco plants which died down as a result of being inoculated with tomato streak, sent up new shoots from below the ground line. In one case this new shoot in turn became necrotic and died within a few days. In the other case the shoot was "speckled mosaic" (Plate 1. Fig. 4) from the very start. This shoot continued to grow for over two weeks when over night it showed several necrotic areas on stem, petiole and leaf blades, and soon dried up and died. This points out the possibility of apparently mosaic plants, carrying a latent "streak" virus.

Inoculating healthy tobacco plants with tomato "streak" produced on the tobacco plants necrotic areas similar to the necrotic areas on streak tomato plants. (Plate 2, Figs. 1 & 3). This type of injury with necrotic areas on tobacco will be spoken of as tobacco "streak". That is, both tomato and tobacco plants have mosaic mottlings without necrotic areas, and apparently both may have necrotic areas associated with mosaic symptoms. On tomato such symptoms have been designated "streak"; it therefore seems justifiable to likewise designate such symptoms on tobacco as "streak" of tobacco. In the case of tobacco the necrotic areas of streak, generally occur first along the midrib and main vines. (Plate 2, Figs. 1, 2 & 3). This no doubt accounts for the rapid drying out and dying of such affected leaves.

Experiment 14.

In order to find out if it is possible to transfer tobacco streak back to tomato again, the following experiment was projected. Six healthy tomato plants were inoculated on September 24th, with tobacco streak juice, resultant from a previous inoculation of tobacco with tomato streak.

No. of plants inoculated	Inoculum	Tomato Streak Date	%	Results
6 2 in greenhouse and 4 on platform of greenhouse but outdoors.	Tobacco streak	Oct. 4-6th	100	All tomato plants showed the characteristic streak symptoms as a result of the inoculation.
6	Uninoculated	----	----	All were healthy at end of the experiment.

This therefore demonstrates that tomato streak is transferable to tobacco where it causes a necrosis, similar in many respects to that on tomato. (Plate 2. Fig. 4). It is also possible to transfer streak back again to tomato from tobacco. Transfers were also made from tobacco to tobacco with positive results in about fifty per cent of the cases.

Experiments outlined above (Exp. 11) also demonstrates that potato streak is transferable to tomato and from tomato to tomato. It would seem therefore that the causal agency in both cases might be the same. However, until more is known of the properties of the juices in question, this interpretation is open to objection because, although the host range is the same it does not necessarily follow that the viruses are identical.

Experiment 15.

INOCULATED HEALTHY TOBACCO PLANTS AS FOLLOWS
Date of Inoculation—October 10.

No of plants inoculated	Source of Inoculum		Results of Inoculation on October 20	October 26	November 2
5	Potato mosaic	1	Healthy	Healthy	Healthy
		2	Healthy	Mosaic	Mosaic
		3	Healthy	Healthy	Healthy
		4	Healthy	Streak N.	Streak N.
		5	Streak. N.*	Streak N.	Streak N.
6	Tomato streak	1	Mosaic	Mosaic	Streak
		2	Healthy	Mosaic	Streak
		3	Healthy	Mosaic	Streak
		4	Mosaic	Streak N.	Streak N.
		5	Streak N.	Streak N.	Streak N.
		6	Streak N.	Streak N.	Streak N.
5	Tobacco streak	1	Mosaic	Mosaic	Streak
		2	Stunted	Streak	Streak
		3	Mosaic	Streak	Streak
		4	Healthy	Healthy	Healthy
		5	Healthy	Healthy	Healthy

*NOTE: N.—plants whose leaves rapidly became necrotic, and plant as a whole, died.

Discussion

The experimental evidence submitted here is believed to be sufficient to warrant the following conclusions.

(1) It has been clearly demonstrated by experimentation and observation that streak is not of a simple nature. No single factor can consistently produce the disease. Environmental conditions are thought to be of primary importance.

(2) Streak belongs to the "filterable virus" type of disease. The evidence recorded here agrees with Gardner (1) and Vanterpool (5) in this respect.

(3) From the standpoint of control, greenhouse environment is perhaps one of the greatest factors to be considered.

(4) It has been demonstrated by experimentation that streak on tomatoes may be produced by inoculating healthy tomatoes with

(a) Healthy potato juice.

(b) Mosaic potato juice.

Johnson (3) states that "most potato varieties uniformly possess the property of inducing a disease in tobacco and *other solanaceous plants* which is infectious in nature and belongs to the class of filterable "viruses." This ability is present regardless of whether the potato is healthy, as this word is generally applied, or affected with one or another of the common virus diseases of the potato." What Johnson has said for potato juice in connection with tobacco, the present evidence bears out for the tomato. It is not necessary to have a combination of potato and tomato viruses, as stated by Vanterpool (5) in order to obtain streak, since the potato juice itself will produce this effect.

(c) Tomato streak juice.

(d) Tobacco streak juice.

(e) Potato streak juice.

In Vanterpool's (5) recent publication on "Tomato Streak in Quebec" he says "the writer has been unable to produce streak in tomato from potato alone." He did produce streak in tomato by using potato streak and tomato mosaic. The present writer however has obtained on several occasions one hundred per cent infection with potato streak alone.

Although the evidence reported here supports the findings of Gardner and Vanterpool in that streak is a virus disease, it does not agree with Vanterpool's contention that tomato mosaic and potato mosaic juices in combination is the true cause of streak. Although, on the other hand malnutrition and environmental conditions have been shown not to be the direct cause of the disease (since it is a virus disease) they are nevertheless of primary importance in so far as prevention and control are concerned.

It has also been demonstrated that tomato streak and tobacco streak, are interchangeable.. Potato streak is also interchangeable with tomato streak and most likely with tobacco streak as well, since streak in tobacco has been produced by inoculations with potato mosaic. In other words the three streak diseases are interchangeable, in so far as host range is concerned. It does not necessarily follow however that the "virus" is identical in all cases.

(5) It has been demonstrated by experimentation that streak (necrosis) may be produced in tobacco by inoculating healthy tobacco with:

(a) Tomato streak.

(b) Tobacco streak.

(c) Potato mosaic.

Vanterpool (5) was unable to produce necrotic areas on tobacco by inoculations with tomato streak, but obtained thereby mosaic symptoms of a severe type, which when inoculated into tomato plants, produced streak. The writer however, more often obtained necrosis (streak) and mosaic, when tomato streak was inoculated into healthy tobacco. Streak in tomato likewise resulted when juice from such artificially produced tobacco streak was used as inoculum. As a possible explanation for the lack of necrotic areas in tobacco as reported by Vanterpool, may be cited the case (experiment 13) where two tobacco plants that had been inoculated with tomato streak became necrotic and died. Both plants however sent up new shoots from below ground, one of which was necrotic as formerly, and the other was "speckled mosaic" (Plate 1, Fig. 4), for a period of two to three weeks, when it in turn became necrotic and died. From the history of this latter plant we know that it contained the streak "virus" yet under certain conditions it only showed mosaic symptoms.

It should be recalled that all plants, from which leaves were taken and used for inoculation purposes, were kept long after these experiments terminated, in some cases for over four months and in no single case did

any of these plants change in any way. That is, a mosaic plant remained mosaic, and did not show any signs of streak. A healthy plant remained healthy, etc.

Experimental evidence submitted in this paper, has shown that it is not necessary to have a combination of viruses in order to produce streak on healthy tomatoes, since the juice from healthy potatoes in itself is sufficient for this purpose. The results recorded here therefore do not agree with Vanterpool's theory that a combination of potato mosaic, and tomato mosaic viruses is the real cause of streak. In support of this contention is the recent publication by Johnson (3) in which he describes experiments where mosaic symptoms, with necrosis, were produced on healthy tobacco and other solanaceous plants, by inoculations with healthy potato juice.

Summary

1. Observations of differences in type and rate of spread of streak are recorded.
2. Preliminary trials in relation to control are outlined.
3. Recommendations for control points out:
   (1) Necessity of planting healthy plants.
   (2) Avoidance of using too much nitrogen.
   (3) Importance of greenhouse management.
4. Experimental evidence is given verifying Gardner (1) & Vanterpool (5) in that "streak" is of the filterable virus type of disease.
5. All parts of a plant carry the infective principle.
6. Apparently there is no particular time in the growth of plant, when it is more susceptible to streak than another time.
7. The following varieties tested were all found to be equally susceptible to streak. Sunrise, Chalk's Jewel, Earliana, Bonny Best, New Globe, Grand Rapids and Veal.
8. Juice from healthy potato plants produced definite streak in tomatoes, as did likewise potato mosaic, and potato streak juices.
9. The experimental evidence reported here does not agree with the theory of a combination of tomato and potato mosaic viruses as the true cause of streak.
10. Potato streak is transferable to tomatoes.
11. Tomato streak is transferable to healthy tobacco, where it produces mosaic symptoms with necrosis.
12. Tobacco streak is in turn transferable to tobacco and back to tomato.
13. Mosaic potato also produces streak in tobacco, as it does in tomato.

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Dominion Department of Agriculture Notes.

SEED BRANCH

Recent Appointments

Vera L. Jones, B.A., Microanalyst, Ottawa.

Eugene Lafresniere, B.S.A., Senior Seed Analyst, Quebec.

Elisée Lavoie, B.S.A., Seed & Feed Inspector, Quebec.

Keith R. Hillier, B.S.A., Seed & Feed Inspector, Western Ontario.

Norman G. Lewis, B.S.A., Seed & Feed Inspector, Alberta.

David W. Thompson, B.S.A., Seed & Feed Inspector, British Columbia.

Seed Branch Services

The Seed Branch of the Dominion Department of Agriculture encourages the production of superior seeds for domestic requirements and export; develops the marketing of seeds, feeding stuffs and fertilizers; maintains laboratories or analytical services; and provides an inspection service for the enforcement of the Seeds Act, Feeding Stuffs Act, Fertilizers Act, and Inspection and Sale Act.

Seed Production

While production is in general a matter for provincial initiative, the Branch cooperates with the Provincial Departments of Agriculture in promoting seed crop competitions, seed fairs, and provincial seed exhibitions. Last year Dominion grants, amounting to approximately one-half the total cost of conducting these services, were paid for the benefit of Canadian farmers as follows:

Seed crop competitions.....	562	$36,454.52
Local seed fairs	179	8,479.96
Provincial seed exhibitions..	15	6,926.99
		$51,861.47

British Columbia specializes in the production of field root and garden vegetable seeds and receives a straight grant of $2,500 towards the development of this industry.

The Canadian Seed Growers' Association is a national organization of farmers who specialize in growing Registered and Extra No. 1 seed. They multiply for commerce the foundation stock seeds which are produced by Dominion and Provincial Experiment Stations and by private growers. This pure variety seed is in great demand for the seed crop competitions, and passes from them to the general trade. An annual grant of $10,000 is paid towards maintaining the Canadian system of seed registration.

Markets Extension

Market reports are issued every two weeks to provide farmers and dealers with reliable information as to current supply, demand and prices of seed, feed and fertilizer. These reports also cover the important United States and European markets through information received by direct correspondence and from Canadian Government trade commissioners. Weekly summaries of market conditions are broadcasted by radio from Ottawa.

With the development of seed centres in favourable districts through the seed crop competitions and the work of the Canadian Seed Growers' Association, a demand arose from farmers' co-operative organizations for information regarding seed warehouses and cleaning machinery. Blue-print plans and specifications of a small elevator, suitable for storing, cleaning and shipping seed, have been prepared and made available at a nominal charge.

Seed, Feed and Fertilizer Analysis

Dominion laboratories are located at Ottawa, Quebec, Toronto, Winnipeg and Calgary. Three seed samples are tested for purity or germination free of charge each year for any person or firm. Microanalysis is made of ground feeding stuffs to determine the constituents and harmful weed seed content. Feeding stuffs and commercial fertilizers receive chemical analysis. These services are available to farmers at reasonable cost, and the official analysis is used as evidence before the courts to protect agriculture against fraudulent practices in the seed, feed and fertilizer trades.

Gist of Legislation

Grasses, clovers and other field seeds, excepting field root and garden vegetable

seeds, must be sold for seeding under definite grade standards. Farmers are exempt from this requirement in selling certain of the larger seeds on their own premises for seeding by the purchaser himself.

Wheat flour mill by-products must be sold in their pure state and according to fixed standards of quality. Commercial mixed feeds are required to be labelled with the specific names of ingredients and the guaranteed chemical composition. Chop feeds are to be ground from entire clean grains, and all feeding stuffs must be free from poisonous weed seeds or harmful adulterants.

With the exception of basic slag and natural rock phosphate, material sold as a fertilizer must contain a total of twelve per cent of nitrogen, potash or phosphoric acid, singly or combined, and the minimum quantities of these that can be claimed as present in a fertilizer are two per cent of atomic nitrogen, two per cent of potash soluble in water, and five per cent of available phosphoric acid. All fertilizers must be labelled to show the brand name and the guaranteed analysis set out in prescribed form.

Voluntary grading is provided for hay, straw, and wild grasses. Baled hay or straw must be tagged to show the name and address of the presser and the weight of the bale. There is a penalty for putting into bales foreign matter which improperly increases the weight or which prejudicially affects the quality. Binder twine offered for sale shall be labelled with the name of the dealer and the number of feed of twine per pound in the ball. Raw hides may be inspected on aplication and stamped to show the net weight of each hide and the grade number. Other materials also come under the Inspection and Sale Act.

Inspection Systems

The laws and regulations controlling the importation and sale of all these products are enforced by a staff of technically trained inspectors. Official samples are taken of imports and of lots in the trade which are suspected violations of the Act concerned. Prosecutions are based on the official laboratory analysis of these samples.

Inspection service is provided for the grading of seeds for commerce on the basis of control samples which have been tested for purity and usually for germination. Field inspections of the growing crops are made for Registered and Extra No. 1 seeds, and before sealing these seeds in sacks the inspector must have satisfactory evidence as to variety and breeding.

With this system of grading and inspection the seed grower can command a premium in the markets for his high quality product, and Canadian farmers are assured as to quality in the seed, feed and fertilizers purchased in the trade.

Educational Work

The technical staff give addresses at farmers meetings, conduct seed judging classes, and assist in agricultural short courses. They write for the farm papers, judge at fairs, and conduct educational books at the larger exhibitions. The District Inspectors are members of Provincial Seed Boards which advise and direct seed production. They co-operate with Provincial officials in developing seed centres and organizing the growers for marketing. Sample collections of economic and weed seeds, feeding stuffs and fertilizers are available at cost for educational purposes. Publications are offered on Weeds and Weed Seeds, Red Clover Seed and Its Impurities, Cleaning Seed, Fodder and Pasture Plants, Farm Weeds of Canada, Oat Hulls in Federal Stuffs, Fertilizer Analyses, and the several Acts administered by the Seed Branch.

FRUIT BRANCH

The activities of the Fruit Branch deal mainly with the administration of the Fruit Act and the Root Vegetables Act, investigation of marketing conditions and problems, compilation of fruit and vegetable crop and market reports, and other matters pertaining to the progress and welfare of the fruit and vegetable industry.

Among the major problems confronting the growers of fruits and vegetables at the present time are those connected with orderly and controlled marketing or merchandizing. Present-day conditions, severe competition, high cost of distribution, and the highly perishable nature of the products, demand that only fruits and vegetables of good and dependable quality, pack and appearance, be placed on the markets and properly controlled

and merchandized, if profitable returns to the growers are to be secured.

The Fruit Branch is actively engaged in dealing with such problems, and one solution to the many difficulties confronting our growers is being found in the strict grading of all products, and in the use of packages suitable to particular markets and conditions. In co-operation with Trade and Growers' Associations and the Canadian Horticultural Council, grades for cantaloupes, apples in crates, plums and fresh prunes, pears, peaches, field tomatoes, cherries and grapes, have been prepared, and the standardization of new forms of packages advocated. Regulations dealing with these grades and packages have now been issued as Orders-in-Council, which form part of, and are in addition to, the present regulations contained in the Fruit Act.

A further major activity of the Branch has reference to the Requested Inspection Service. This work is actively occupying the attention of the greater part of the permanent staff over a large part of the year, and during the heavy shipping seasons the staff has to be considerably augmented. Many shippers, realizing the necessity of preventing as far as possible the shipment of under-grade or poor quality fruit and vegetable products to market, request inspection at shipping point, and thus prevent in very large degree the financial losses which during many past seasons have been an enormous drain on the industry. The inspection service was inaugurated at the request of certain shippers in the Okanagan Valley, B.C., at the beginning of the shipping season 1924-25, and from a small beginning, it has spread in the course of three shipping seasons to all parts of the Dominion. From the beginning of the 1926-27 season up to December 31, over 6,500 carlots were inspected at shipping point. The Requested Inspection Service also provides for re-inspection at destination of cars inspected at shipping point, and the inspection of all other cars of domestic and imported perishable fruit and products. This service does not in any way affect the established Inspection Service for purposes of administration of the Fruit Act or the Root Vegetables Act. It is a special service, provided on a basis of cost averaging $5. per carload; it is not compulsory but a marketing convenience which is proving helpful in the handling of perishable fruit products.

Market demands are moving in the direction of smaller packages than those in general use at the present time, particularly with respect to apples, and the Fruit Branch is closely co-operating with certain shippers in making experimental shipments to various domestic and overseas markets, of apples packed in boxes which are one-half the capacity of the standard box. Reports already received show that this new package, which is specially designed to attract the smaller householder and dweller in apartment houses, is meeting with a good reception. It is estimated that the per capita consumption of apples in the leading apple-consuming countries is from two to four per week. This is apparently a very light consumption, and the half apple box packed in an attractive manner, is designed to increase distribution and consumption, a matter which should not be very difficult to accomplish. The tendency of the market, however, seems to be for an even smaller package than the half-box, and this problem is being given very serious consideration.

DAIRY AND COLD STORAGE BRANCH

Permanent Dominion Dairy Produce Graders are being appointed at Calgary and Edmonton in Alberta. Heretofore the work has been done by Provincial Graders acting as Dominion officials when called upon to do so.

EXPERIMENTAL FARM BRANCH

Poultry Division

Mr. Harry S. Gutteridge, of Vancouver, B.C., Graduate of the University of British Columbia in Poultry Husbandry, has been appointed as Poultry Husbandman, in the Poultry Division, Central Experimental Farm, Ottawa, and started work on July 27, 1926.

This position was formerly occupied by Mr. W. W. Lee who resigned in March, 1926. Mr. Gutteridge is in charge of the poultry investigational work at the Central Experimental Farm, Ottawa.

La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

Les Colloides Argilieux du Sol.*

A. DEMOLON

Directeur de la Station Agronomique de l'Aisne

Le trait le plus caractéristique du développement de la biologie depuis une vingtaine d'années, c'est peut-être l'intervention croissante de la chimie colloïdale. Bien qu'au point de vue théorique nous soyons toujours dans l'ère des discussions, il n'en est pas moins vrai que bon nombre de faits expérimentaux sont aujourd'hui solidement établis, qui nous démontrent qu'à un certain degré de dispersion de la matière correspond l'apparition de propriétés nouvelles ne rentrant pas dans le cadre des lois stéchiométriques de la chimie classique. Si la médecine apparaît, parmi les applications de la biologie, comme celle qui a le plus directement bénéficié des notions nouvelles, l'agronomie est également susceptible d'en faire son profit. Le sol n'est-il pas avant tout un milieu de culture? Si les bactériologistes croient généralement avoir créé l'étude des "milieux de culture", ne convient-il pas de considérer que le plus ancien et aussi le plus important, parmi ceux-ci, c'est le sol?

Les colloïdes argileux, qui sont de beaucoup les plus importants, peuvent être envisagés à divers points de vue; je ne les examinerai que dans leur rapport avec les propriétés des sols en agriculture.

Nous nous sommes adressé pour leur étude à la terre à briques; sous cette désignation un peu vague, nous entendons la couche supérieure des limons pléistocènes, qui, dans le nord de la France, offrent un développement remarquable. Au point de vue agro-géologique, le mot doit donc être considéré comme synonyme du "Lehm" des auteurs allemands et du "loam" des auteurs de langue anglaise. Cette terre à briques, qui n'est pas une argile à proprement parler, dérive par décalcification du loess sous-jacent. Elle représente une formation de transport résultant de la destruction, sous l'action des eaux, de sédiments tertiaires parmi lesquels les argiles de décalcification de la craie ont joué le rôle le plus important.

Cette terre à briques nous est apparue comme un excellent matériau d'étude.

En effet, d'une part, c'est elle qui a donné naissance à nos meilleures terres de cultures industrielles du nord de la France. A cet égard, terre à briques est synonyme de "terre à betteraves"; il ressort d'ailleurs avec netteté ce fait assez curieux, qu'au point de vue purement chimique, la mise en culture a eu pour résultat d'enrichir considérablement ces sols originellement pauvres du fait même de leurs conditions de formation. D'autre part, si, dans les sols ordinaires, il faut compter avec la coexistence des colloïdes argileux et humiques, dans la terre à briques les colloïdes organiques sont inexistants et, de ce fait, l'étude des colloïdes argileux se présente dans des conditions très favorables. Trois questions retiendront particulièrement notre attention.

Mode d'Estimation des Colloides

1o Un certain nombre de méthodes utilisent les phénomènes d'absorption, en particulier la propriété que les colloïdes argileux possèdent, à un haut degré, d'absorber la vapeur d'eau. L'absorption des matières colorantes, des bases, peut aussi fournir une mesure de

*Extrait de "Chimie et Industrie."

la teneur en colloïdes argileux, nous y reviendrons ultérieurement.

2o Une deuxième catégorie de méthodes est basée sur la mesure des quantités de chaleur dégagée au contact de l'eau. Déjà en 1909, un travail de Muntz et Gaudechon avait montré que cette quantité de chaleur croit avec la finesse des éléments et qu'en pratique, elle est due, sinon en totalité, du moins pour la plus grande partie, aux éléments colloïdaux, les autres constituants, même à l'état de grande dispersion, ne donnant pas de dégagement appréciable de chaleur par hydratation. Muntz et Gaudechon avaient observé, à cette époque, que plus les argiles dégagent de chaleur au contact de l'eau, plus elles sont aptes à en fixer dans une atmosphère humide. Toutefois ces auteurs n'avaient pas remarqué tout l'intérêt que présentaient ces constatations au point de vue de la teneur en colloïdes et de ses conséquences culturales. Ces recherches ont été reprises récemment par l'école américaine, notamment par Bouyoucos, de la Station de Michigan.

Ce dernier détermine d'abord la chaleur dégagée par le sol total, puis celle qui correspond à une certaine quantité de colloïdes extraits du même sol, d'où il déduit, par une règle de trois, la teneur du sol lui-même en colloïdes, Bouyoucos a trouvé ainsi que la proportion de colloïdes présents dans le sol est très supérieure à ce que l'on croit généralement. Ses résultats conduiraient notamment à une teneur pouvant dépasser 50 % dans certains limons argileux.

3o On fait en général l'analyse mécanique qui fournit la teneur en argile. Toutefois, toutes les méthodes utilisées jusqu'ici comportent de sérieuses critiques et donnent certainement des chiffres trop faibles, en particulier celle qu'a utilisée Schloesing et qui constitue encore aujourd'hui la méthode officielle des stations agronomiques françaises. A l'état normal, les colloïdes argileux du sol sont floculés, ils constituent des agrégats assez volumineux, et si l'on opérait l'analyse mécanique par lévigation en utilisant une eau comparable à celle qui circule dans le sol, on n'obtiendrait aucune trace d'argile définie comme particules de diamètre inférieur à 5 μ. Toute séparation de l'argile colloïdale doit donc préalablement comporter la destruction de ces agrégats et l'obtention de la dispersion maxima. Or, il est bien établi que par délayage en s'aidant du doigt ou d'un agitateur muni d'un caoutchouc, par agitation mécanique même prolongée, on arrive évidemment à décaper d'une manière satisfaisante les particules minérales, mais il reste toujours des agrégats de matière colloïdale qui peuvent correspondre à une proportion importante de matière argileuse. La cuisson, qui a été recommandée par certains auteurs, ne paraît pas plus satisfaisante, en raison des phénomènes de thermo-coagulation qu'elle entraîne.

Pour notre part, l'expérience nous a montré que, pour la terre à briques, on obtenait la proportion maxima de matière argileuse en opérant de la manière suivante. On prend 10 gr. de terre qu'on décalcifie par HCl à 1 %; on lave à l'eau distillée jusqu'à élimination de l'ion Ca puis on met en suspension dans de l'eau renfermant de 0,5 gr. à 1 gr. de soude caustique par litre: on agite mécaniquement et on laisse déposer 24 h. dans un flacon-goulot de 1 l., on siphonne et on renouvelle l'opération autant de fois qu'il est nécessaire.

Les alcalis favorisent la dispersion en tant que générateurs d'ions OH entraînant la répulsion des particules argileuses ayant une charge électrique de même signe. Mais on observe un maximum au delà duquel l'alcali entraîne la coagulation et qui est voisin N/20 pour la potassse et la soude.

On pourrait, au lieu de soude, employer une solution de savon amygdalin à 0,2 % qui, nous l'avons montré, exerce une action stabilisatrice très marquée sur les colloïdes argileux, par l'abaissement de la tension superficielle qu'il provoque. En tenant compte de ces diverses considérations, nous avons toujours élevé très sensiblement le taux d'argile colloïdale que nous donnait dans les limons l'application des méthodes officielles. Si la séparation des colloïdes est totale, le résidu ne possède plus de pouvoir absorbant appréciable.

Constitution Chimique de l'Argile Colloidale

L'argile colloïdale ainsi obtenue, constituée par des particules de diamètre inférieur à 5 μ se présente au microscope comme formée d'une masse amorphe possédant vis-à-vis des colorants une réaction basophile et qui englobe des particules brillantes, gran-

ulaires, formées par du quartz; on n'y trouve guère d'autres débris minéraux. La densité du quartz étant de 2,66 et celle de l'argile colloïdale étant comprise entre 2,53 et 2,58 la séparation est très difficile et l'on peut dire que l'argile pure reste jusqu'ici une fiction (*). Si on cherche à opérer des fractionnements, on ne modifie guère la composition. Toutefois l'analyse montre que la matière argileuse tend à se rapprocher au point de vue centésimal de l'acide hypothétique alumino-silicique $H^2Al^2Si^2O^8$ aq.

Les impuretés qui l'accompagnent sont les suivantes:

1o Comme nous l'avons dit, une petite quantité de *silice*. Cette silice se trouve à l'état de quartz finement dispersé, mais non pas à l'état de silice colloïdale proprement dite; elle passe à travers les filtres, son rôle paraît d'ailleurs secondaire; par exemple, elle n'a aucune action sur les sels neutres.

2o Le *titane* fait toujours partie de la matière argileuse, où il se concentre et où sa proportion peut atteindre 1 %.

3o Il en est de même du *manganèse*, qui se concentre également dans la matière argileuse, par un phénomène d'absorption.

4o Beaucoup plus important quantitativement est l'*oxyde de fer*. Il existe sous deux formes que nous avons pu séparer, grâce à l'emploi de l'acide oxalique, à l'état d'oxyde hydraté et à l'état de combinaisons silicatées. C'est aussi dans la partie colloïdale qu'il se concentre par un mécanisme qui réside dans la précipitation mutuelle de deux colloïdes de signe contraire représentés par l'oxyde de fer colloïdal et l'argile proprement dite. C'est ce phénomène de teinture qui engendre la rubéfaction des sols.

5o *L'eau*.—La matière argileuse, séchée à 105° jusqu'à poids constant, retient une proportion d'eau généralement voisine de 11 %. Lorsqu'on étudie comment se comporte cette eau sous l'action de températures croissantes, on constate qu'elle s'élimine progressivement dès 200° et que la totalité a disparu dès 500°; pour la kaolinite, la perte commence seulement à 500°. Cet argument, joint à un certain nombre d'autres, doit faire considérer la matière argileuse des sols comme tout à fait différente de la kaolinite des kaolins. On ne peut la ranger dans la catégorie des allophanes, dont la structure n'est pas kaolinique, mais on peut plutôt la rapprocher de l'halloïsite, qui perd son eau plus facilement que la kaolinite. Ce qu'il importe surtout de retenir, c'est que l'argile de la terre à briques retient avec énergie une proportion d'eau colloïdale de l'ordre de 10 %.

6o A côté de ces éléments fondamentaux, on trouve toujours des traces de *bases* diverses, chaux, magnésie, potasse et soude. Si l'oxyde de fer s'élimine facilement, il n'en est pas de même de ces bases énergiquement retenues. Il faut des lavages très prolongés à l'eau chlorhydrique pour éliminer la totalité de la chaux, et, après cette opération, si l'on pratique une fusion, on trouve encore du calcium à l'état de composés d'absorption. Le potassium est d'une élimination plus difficile encore. L'attaque fluorhydrique en donne fréquemment jusqu'à 3,50 % d'argile colloïdale, ce qui représente une quantité considérable, d'où on a souvent conclu à l'inutilité de la potasse dans ces sols. Enfin la magnésie est constante dans ces argiles. Quant à la soude, elle n'existe qu'à l'état de traces.

On ne peut guère considérer qu'il persiste dans la matière argileuse des limons des particules de composition différente. A notre sens, il ne faut pas voir dans l'argile colloïdale une substance chimique spéciale, il y a avant tout une modification d'état de la forme cristalline à la forme amorphe, et c'est de l'état physique de ces argiles amorphes que découlent leurs propriétés spéciales. La présence d'hydrogels d'alumine et de silice est d'ordre purement hypothétique; le rôle tout à fait prépondérant appartient aux colloïdes aluminosiliciques.

Propriétés des Colloides Argileux

La matière argileuse se comporte comme un colloïde électronégatif. Comme les autres suspensoïdes, elle est très sensible à l'addition de traces d'électrolytes. Dans l'étude de la floculation, il importe de réduire au minimum la perturbation liée au déplacement des bases, et de pouvoir négliger la quantité d'ions déplacés vis-à-vis de ceux introduits. Dans ces conditions, on vérifie la règle de Schulze: le pouvoir floculant dépend de la valence des cations et non de la concentration en sel, ou du poids atomique. Le pouvoir flo-

* La chimie des colloïdes n'est pas celle des corps purs; Sörensen, qui a fait cristalliser l'albumine de l'œuf en présence de sulfate d'ammonium, n'a-t-il pas observé que celle-ci retenait environ 1 % de sel non susceptible d'être enlevé par dialyse?

culant s'exprimera comme suit: sodium: 1; ammonium et potassium: 2,5; magnésium et calcium: 1; fer et aluminium: 30.

D'une manière générale, la vitesse de floculation augmente avec la concentration en ions H du milieu. Les alcalis se comportent comme des agents peptisants, les ions OH stabilisant le suspensoïde argileux jusqu'à une concentration limite correspondant à un p_H voisin de 12. L'eau de chaux présente toutefois une anomalie remarquable, en provoquant la coagulation dès qu'on a dépassé p_H 7,- 1, c'est-à-dire la neutralisation. Quant aux non-électrolytes, alcool, glycerine, ils sont sans action.

Phénomènes d'Absorption

Les phénomènes d'absorption, c'est-à-dire les variations de concentration à la surface de séparation de deux phases, prennent leur maximum d'importance dans le cas des colloïdes. Pour l'argile colloïdale comme pour la plupart des autres colloïdes, ces phénomènes comportent des échanges chimiques entre la paroi et le liquide. Nous n'indiquerons pas ici les théories qui ont cherché à rendre compte du phénomène, nous nous bornerons à indiquer quelques faits d'ordre expérimental.

Tout d'abord, la matière argileuse fixe les colorants basiques et laisse intacts les colorants acides. Le bleu de méthylène, le bleu Victoria, le violet de gentiane, le vert brillant, sont fixés par un phénomène de teinture, le rouge Congo, le ponceau, le bleu de méthyle, l'érythrosine restent intacts. Ce sont d'ailleurs les composés qui ont le poids atomique le plus élevé qui sont fixés le plus énergiquement.

L'argile absorbe également les alcaloïdes. Si l'on fait agir du bisulfate de quinine, la quinine est fixée, tandis que le radical acide ne l'est pas. L'alcaloïde peut être ensuite redissous dans l'éther.

Les oxydes métalliques, chaux, baryte, oxyde d'argent, oxyde de cuivre, sont absorbés énergiquement. Si l'on fait agir sur un certain poids d'argile l'eau de chaux, en répétant l'opération un certain nombre de fois, on observe une série d'équilibres successifs et des fixations décroissantes. La courbe qui traduit ces équilibres en fonction des concentrations est une courbe hyperbolique correspondant à l'équation:

$$\frac{y}{m} = K\ C^{\frac{4}{p}} = 7{,}50 \times C^{0-40}$$

C'est une courbe d'absorption. L'argile peut ainsi fixer 6 à 7 % de chaux. Si l'on étudie le déplacement de cette chaux par l'acide carbonique, on voit qu'il n'est que partiel: (57 %); il est un peu plus considérable sans être total en présence de chlorhydrate d'ammoniaque. Si l'on fait réagir sur la matière argileuse des solutions de baryte, de potasse, d'oxyde de cuivre, d'oxyde d'argent, on obtient les mêmes phénomènes.

En étudiant l'absorption simultanée de la potasse et de la chaux en solution équivalente, on observe un phénomène de partage entre les deux bases, la chaux se fixant plus intensément que la potasse. De même, dans une solution d'oxyde de cuivre et d'oxyde d'argent, l'oxyde de cuivre se fixe plus intensément que l'oxyde d'argent. Chacun de ces corps possède donc pour l'absorbant argileux une affinité spécifique, et l'on conçoit que la détermination de la capacité de saturation d'un sol fournisse une mesure de sa teneur en colloïdes argileux.

Lorsqu'on fait réagir, non pas une base, mais un sel, les phénomênes se présentent différemment, et l'on observe un double échange d'ions. Il est intéressant, en particulier, de suivre ce qui se passe pour l'ion potassium. On a admis généralement que ses sels réagissaient dans le sol avec CO^3Ca, suivant la formule:

$$CO^3Ca + 2KCl = CO^3\,K^2 \times CaCl^2;$$

en réalité, l'ion actif qui se substitue à l'ion K est celui qui existe à l'état de complexe d'absorption, c'est donc par l'intermédiaire des colloïdes argileux que s'effectue la réaction.

En l'absence d'ions Ca, le pouvoir absorbant n'est pas annihilé; il n'est que fortement diminué. La capacité d'absorption des colloïdes argileux est d'ailleurs considérable, et dans nos essais, la terre à briques a pu fixer environ 1 % de KCl, ce qui correspondrait à une quantité de l'ordre de 20 t. pour la couche arable superficielle.

Inversement l'ion K adsorbé peut être déplacé au moins partiellement par l'ion Ca. Tous les sels de chaux solubles sont sensible-

ment équivalents et agissent par leurs cations, les anions n'intervenant pas. Les divers engrais calciques one gàn?ralement une action mobilisante, mais moindre. On voit donc que l'absorption et la mobilisation du K apporté par les engrais potassiques sont en relation avec les colloïdes argileux et se trouvent régies par les conditions de déplacement réciproque des deux ions Ca et K dans ces colloïdes.

La matière argileuse nous apparaît donc comme susceptible de retenir plus ou moins énergiquement une certaine quantité de bases. L'élimination de ces bases auxquelles se substituent des ions hydrogène, a pour résultat d'entrainer l'acidification de la matière argileuse. Celle-ci, prise sous une concentration d'environ 3 %, nous a donné des p_H compris entre 2,4 et 3,9.

D'autre part, lorsqu'on suit la variation du p_H par addition d'un alcali, on obtient une droite, comme cela se produit pour la saturation d'un acide faible par une base forte avec dissociation des combinaisons formées. Ces faits comportent quelques conséquences intéressantes: tout d'abord ils nous apportent l'explication d'un des mécanismes susceptibles de concourir à l'acidification des sols, et vraisemblablement des plus importants. D'autre part, la décomposition des carbonates, de CO^3Ca en particulier, par les colloïdes argileux, avec retour à la neutralité, nous montre par quel mécanisme la réaction du sol peut se maintenir au voisinage de la neutralité. Enfin, nous voyons comment, grâce à l'argile, le sol, est naturellement tamponné, c'est-à-dire à l'abri de brusques variations de son p_H. Un milieu tampon comporte en principe l'association d'un acide faible avec un de ses sels; c'est précisément le cas qui se trouve réalisé dans le sol en présence des colloïdes argileux. Les applications de chaux caustique ou d'acide sulfurique modifieront peu sa réaction.

Conclusion

En résumé, un sol, envisagé non comme simple support mais comme milieu biologique, doit être bien pourvu en colloïdes pour être un sol fertile; c'est par perte de leurs colloïdes argileux que des sols, autrefois riches, ont évolué vers la stérilité actuelle. Ces colloïdes commandent les propriétés physiques de ces sols et le mécanisme de leur pouvoir absorbant. C'est avec une netteté admirable que, dès 1872, Schloesing avait entrevu toute l'importance qui s'attachait à cette argile colloïdale, bien avant le développement actuel de l'étude des colloïdes. Rendons hommage à ce grand précurseur.

NECROLOGIE

Nous apprenons avec beaucoup de regrets la mort de notre confrère, Monsieur Hector Piette, B.S.A. de la promotion de 1916, de l'Institut Agricole d'Oka, décédé à St. Jovite, comté de Terrebonne. Le défunt exerca les fonctions d'agronome officiel du comté de l'Assomption, jusqu'au jour où le mal implacable qui devait avoir raison de sa constitution l'obligea à abandonner le travail, pour se soigner.

Tous ceux qui ont connu Hector Piette en conserveront le souvenir d'une homme plein de distinction et d'aménité. Il ne comptait que des amis parmi ses confréres.

Au nom de tous les membres Canadiens français de la C.S.T.A., nous adressons l'expression de notre profonde sympathie à la famille du cher défunt à l'occasion de 'épreuve douloureuse qu'elle vient de subir.

Concerning the C.S.T.A.

GRANT FROM CHILEAN NITRATE COMMITTEE

The Society has received a grant of $600.00 from the Chilean Nitrate Committee, through Mr. B. Leslie Emslie, Canadian Delegate on the Committee. It is expected that Mr. Emslie will, at a later date, discuss with the General Secretary the manner in which this grant is to be used, and in the meantime the money has been credited to the funds of the Society.

This is the third donation that the Chilean Nitrate Committee has made to the C.S.T.A. In 1924 they awarded a scholarship of $600.00 for research work is soil fertility, and in 1926 made a grant of $1,000.00 to the Society, to cover the cost of organizing a Bureau of Records and Employment.

Mr. Emslie is President of the Western Ontario branch of the C.S.T.A.

NOTES

The General Secretary attended the annual meeting of the Nova Scotia local at Truro on January 28th. A dinner was held at the Agricultural College, followed by a business session during which there was a very interesting discussion concerning the Society and its affairs.

The following day, January 29th, the General Secretary visited Moncton, N.B., where an informal meeting of local members was held. The annual meeting of the New Brunswick local had already been held at Woodstock, N.B., on January 19th.

The Eastern Ontario local held a dinner and bridge at Ottawa, on January 28th.

Dr. Creelman is in Vancouver, waiting for the Annual Convention of the Society. His address is: Westwood Apartments, 1873 Nelson St.

While definite dates for the Convention have not yet been decided, the meetings are likely to be held from June 15th to 18th, with the opening day in Victoria and the last three days in Vancouver. The annual meeting of the Canadian Seed Growers' Association will immediately precede the C.S.T.A. Convention.

The Dominion Civil Service Commission is advertising for a Tobacco Specialist for the Central Experimental Farm, Ottawa, at an initial annual salary of $1920 with increases of $120.00 up to a maximum of $2,400.00. Full particulars can be obtained from the General Secretary.

It is expected that the 1927 List of Members will be printed about the end of February. From present indications it will contain about 975 names.

A detailed statement of the Society's financial operations is enclosed in all copies of this issue which are being mailed to members. Comments will be appreciated.

We learned recently that Harold Fry (O.A.C. '14) has been appointed to the staff of the Saskatchewan Wheat Pool, Regina. He has been Associate Editor of the *Farmer's Advocate*, at London, Ont., for several years.

S. B. Stothers (O.A.C. '16) Agricultural Representative at Clinton, Ont., has been transferred to Essex, Ont.

H. E. Miller (O.A.C. '26) is with the Windsor Creamery, Ltd., at Windsor, Ont.

A. B. Banks (O.A.C. '26) is Agricultural Representative for Colchester County N.S. His office is at Stewiacke.

A. M. Brown (Manitoba '14) is with the Dominion Rust Research Laboratory at Winnipeg, Man.

Paul M. Daly (Macdonald '21) is farming at Arnprior, Ont.

H. R. Murray (O.A.C. '23) is Graduate Assistant in Genetics at the Agricultural Experiment Station, New Haven, Conn. He is working towards his Doctors' degree.

The address of D. B. Flewelling (Macdonald '12) is 1086 Bute St., Vancouver, B.C.

The address of F. W. Gregory (O.A.C. '25) is P.O. Box 35, Niagara Falls, Ont.

H. J. Siemens (Manitoba '25) is taking graduate work in Agronomy at the University of Minnesota.

D. H. Galbraith, Vulcan, Alta., (O.A.C. '03) has been elected President of the Alberta Seed Growers' Association for 1927.

The Fusarium Wilt of China Asters.*

A. B. JACKSON

Dominion Laboratory of Plant Pathology, St. Catharines, Ontario.

INTRODUCTION

Aster wilt is very prevalent and destructive ı Ontario. Many commercial aster growers ıve been forced by the wilt disease to dis-ıntinue the culture of this valuable flower. .any gardeners who strive every year to have ı attractive bed of asters meet disappoint-ent or only partial success due to losses om wilt. Aster wilt is often discussed by ɔrists in their publications and at their con-:ntions and invariably the absence of any tisfactory control measure is pointed out. :veral phases of the disease itself are not əll understood. For these reasons the pre-nt studies were undertaken at the suggestion Dr. J. H. Faull, Professor of Botany, Uni-rsity of Toronto, and carried on under his rection. The work was begun at the Botani-l Laboratories of the University of Toronto ıd concluded at the Dominion Laboratory Plant Pathology at St. Catharines. The :iter is indebted to Dr. J. H. Faull for aid ıroughout the work and to Dr. G. H. Ber-ley for many helpful suggestions.

Review of Literature

W. S. Beach (1) studied this disease care-lly in Michigan and reviewed the work done to 1917. Beach has made many contribu-ns to our knowledge of the disease. He scribed the symptoms of the wilt, isolated : causal organism, proved its pathogenicity, scribed it and proposed the name *Fusarium ıglutinans* var. *Callistephi.* The organism fered from *F. conglutinans* Wr., the cause cabbage yellows, in having slightly smaller cro and macro conidia and in being non-:hogenic to cabbage.

Since 1917 the literature on the subject of sarium has become very extensive but only ɔ references could be found bearing direct-on Aster Wilt. Stokdyk (15) found, as did ach, that the aster wilt organism was not :hogenic to cabbage. Gloyer (6) reports sarium of asters as seed borne and that d disinfection assists in control. Applications of Mercuric Chloride 1-2000 were also effective in controlling damping off in the seed bed and did not injure the seedlings. Strengths up to 1-1280 were safe to use on older seedlings if the soil was moist. Much of the general literature on Fusarium bears indirectly on the aster problem and will be referred to throughout this paper at such places as a correlation exists.

Prevalence of Aster Wilt in Ontario

The writer examined aster beds at many points throughout Ontario in 1924, 1925 and 1926. The disease was more severe in the first year when the average loss would be about 10% to 20% while in the two last years it has been from 10% to 15%. Numerous cases of very heavy losses were met with, however, in each season. Where the soil has become aster-sick the losses are always severe whenever the growing of asters is attempted and 75% or more of the plants may be lost. Aster-sick soil has been found in several gardens and asters were observed to be repeated failures in such cases. Such garden soil without further inoculation also caused severe wilt of asters in the greenhouse.

Varieties of Asters Susceptible to Wilt

Varietal susceptibility of asters to wilt requires further study and is a difficult problem since varieties seem much confused and intermixed. Many varieties belong to certain well-defined classes while others are intermediate. One variety or class may differ from another in (1) type of flower, (2) manner of growth, and (3) season of flowering.

The three types of flowers most commonly grown in Ontario are—

(1) Chrysanthemum-shaped which have long, twisted and strongly recurved petals. Examples are Comet, Crego, Ostrich feather.

(2) Peony-shaped with wider petals strongly incurved. Examples are Peony Perfection, Ball, and Triumph.

*Contribution from the Division of Botany, Experimental Farms Branch, Department of Agriculture, Ottawa, Canada.

(3) Imbricated flowers, also called branching or plain type, with petals variously overlapping as in Victoria and Queen of the Market.

There are also single and quilled asters.

Beal (2) has drawn up a very serviceable system of classification based upon the habit of growth and embodying the above types of flowers. The use of this classification should help to clear the confusion of aster varieties. His divisions according to habit of growth of asters are (1) Tall pyramidal, (2) Tall Branching, and (3) Dwarf. Muller (11) has prepared a list of recommended varieties of asters which he has arranged according to their season of blooming.

Mr. F. L. Drayton reports that "Heart of France" shows considerable resistance at Ottawa. The writer has not found special resistance in any variety at St. Catharines. Individual plants which were apparently resistant to wilt have, however, shown up in greenhouse experiments. Seed has been secured from some of these and has been tested for resistance in comparison with commercial seed.

Prevalence of Aster Yellows

Aster "Yellows" is an entirely different disease from wilt, yet very few growers distinguish between them and a great deal of the losses caused by this trouble have no doubt been attributed to wilt.

This disease was more severe than wilt in Ontario during 1925, but less so in 1926. Many beds have been ruined entirely and very few beds escaped some injury, the average loss probably being above 25%. R. E. Smith (14) first described Aster Yellows in 1902. Dr. Kunkle (9) has shown in 1923 that this disease is of a true mosaic or virus type, and that at Yonkers, New York, the species of Leaf-hopper, *Cicadula sex-notato* Fall, is responsible for the transmission of yellows from diseased to healthy plants. The disease manifests itself by producing yellowish, sickly foliage, with usually upright slender manner of growth and deformed, pale or greenish-colored bloom which is worthless. A plant which contracts the disease early in the season dies before blooming time. Often one side of a plant shows the symptoms more than the other side but at no time is there definite wilting. (Plate 1, A & B).

Prevalence of Aster Bug Injury

The tarnished plant bug *Lygus praten* Linn, or aster-bug as it is commonly call does a great deal of injury in Ontario. T insects attack the young terminal shoots the plant and stop their growth. New si laterals are thrown out, which in turn may attacked, finally resulting in a stunted, bus plant, with small flower buds some of whi never open. (Plate 1, B).

Description of Wilt

In young seedlings the disease acts ve similar to damping off except that the atta is from below the surface of the soil rath than at the surface. A wilted seedling show upon examination, that the root system a especially the main central root, is alm entirely rotted away. This occurs before a symptoms show above ground except possib stunting of growth. The entire plant so collapses. In older seedlings stunting is ve evident, the root system is much reduced loss of branches, and the roots as well parts of the stem above ground are usua darkened. (Plate II, A). Wilt may n show until the plants are much older or ev until they are approaching maturity. In su cases stunting may or may not be evide The bottom leaves are the first to show wilti and soon wither up. This process contin up the stem until the plant is dead. Ve often a plant is healthy until about to bloo when it suddenly wilts from top to botto (Plate I, C). In the case where a matu plant is affected with wilt, the root system much reduced and darkened, as with young plants, while the stem shows a collapsed c tex with lesions and black streaks (Plate C). On account of these characters the d ease is commonly called "stem rot". A pinki mould is often seen on the decayed stem ne the ground. This is produced by the sporu tion of saprophytic forms, usually Fusar The causal organism of wilt gains entran through the roots and grows upward throu the vascular system of the plant.

Isolations

Aster wilt is caused by a species of Fusa um described and named by Beach as *Fusa um conglutinans* var. *Callistephi*. This ganism has been isolated many times by t author from wilted asters, which had be collected in various parts of Ontario. Ma

secondary fungi were found to be present but these were less abundant in the upper parts of wilted plants. The writer made his isolations by first sterilizing the surface in mercuric chloride then scraping away the cortex exposing the woody elements. Bits of this tissue were first rinsed in mercuric chloride, next in sterile water and then planted on potato agar in test-tubes or in petri dishes. Usually pure cultures of the aster wilt Fusarium resulted. Single spore cultures were secured and the organism identified by pathogenic and microscopic studies. The organism repeatedly satisfied Koch's rules of proof. Plate II, A shows an inoculated and a check plant and Plate II, B shows the results of re-isolations made from these same two plants. It may be noted that there is no fungal growth from the healthy one.

Besides the above mentioned organism several others were isolated in the same manner from wilted asters. These were Fusaria for the most part. Only a few have been identified or tested for pathogenicity. Four forms proved to be strong pathogens and are probably important factors in the cause of wilt, while the others are no doubt secondary fungi. A culture of *Fusarium conglutinans* Wr., the cause of cabbage yellows, was secured from the University of Wisconsin for comparative purposes. Also two strains of *F. conglutinans* var. *Callistephi* Beach, were secured from the same place. One of these was isolated at Madison, Wisconsin, and the other is the strain with which Beach worked.

The following is a list of organisms studied and the synonym given to each; unless otherwise stated these were isolated from wilted asters.

F 1. *Fusarium conglutinans* var. *Callistephi* Beach, St. Catharines and Toronto.

F 3. *Fusarium* sp. from asters sent from Brandon, Manitoba by I. L. Conners.

F 4. *F. conglutinans* var. *Callistephi* Beach, isolated at Madison, Wisconsin.

F 5. *F. conglutinans* var. *Callistephi* Beach, Beach's strain.

F 7. *F. angustum* Sherb. St. Catharines.

F 8. *F. conglutinans* var. *Callistephi* Beach, isolated by F. L. Drayton, at Ottawa.

F 9. *F. conglutinans* Wr. from Cabbage at Madison, Wis.

F 100C. *Fusarium* sp. St. Catharines.

F 103A. *F. culmorum* (W. Smith) Sacc. St. Catharines.

F 103C. *Fusarium* sp. St. Catharines.

F 105. *Fusarium* sp. St. Catharines.

V. C. *Verticillium* sp. St. Catharines.

V. A. *Verticillium ovatum*, B. & J., isolat- at St. Catharines from raspberry. (3).

Single spore cultures were secured of F 1. F 3, F 4, F 5, F 7, and F 9, while with each of the others, dilution series were poured in petri dishes several times in succession and colonies picked off which were apparently from single spores. Several other organisms have been isolated from aster and secured in pure culture but have not been studied nor tested for pathogenicity. These include *Fusaria* sp., *Botrytis* sp. *Isaria* sp, and an Ascomycete resembling the genus *Gnomonia*.

Pathogenic Studies

All the organisms listed above were tested for pathogenicity to aster, while only a few of the forms were used to inoculate cabbage. The soil in all cases was first sterilized for one hour at five to six pounds pressure. Two methods of inoculation were used—(1) dipping the roots of one month old seedlings in a spore suspension and (2) inoculating the soil with scrapings from the cultures and then planting seeds. These seeds were first sterilized for one half hour in Mercuric Chloride 1:1000.

Early tests showed that wilt was very slow in appearing where the temperature of the soil did not average above 20°C. and during subsequent tests care was taken to keep the temperature in the greenhouse between 20° and 25°C.

Table No. 1 shows a summary of results when aster seedlings were inoculated by root dippings.

Table No. 1.

Root inoculations of aster seedlings.

No. of Pot	Inoculum	No. of Plants	Healthy Plants After 10 days	After 20 days	After 30 days
1.	Check.	6	6	6	6
2.	Check.	6	6	6	6
3.	F.1. *Aster Fus. (Ont.)	12	6	2	0
4.	"	12	3	1	0
5.	F.4. *Aster Fus. (Wis.)	5	3	0	0
6.	"	6	4	1	1
7.	F.5. *Aster Fus. (Mich.)	12	3	1	0
8.	"	12	7	5	0
9.	F.9. *F. conglutinans* (Wis.)	5	5	5	5
10.	"	5	5	5	5
11.	F.3. *Fusarium* sp.	6	3	1	1
12.	F.7 *F. angustum*	9	6	6	6
13.	Aster-sick soil.	6	3	1	1

*Aster Fus.—*fusarium conglutinans* var. *Callistephi* Beach.

Table No. 2.

Results of soil inoculations.

Pot No. of	Inoculum	No. of Plants	Healthy Plants After 10 days	After 20 days	After 30 days	After 40 days
1 A.	Check.	19	18	18		
1 B.	"	35	32	27	20	18
2 B.	"	19	16	15	15	13
10 B.	"	19	20	20	17	15
20 B.	"	38	38	38	38	36
21 B.	"	37	36	36	36	34
2 A.	F. 1. Aster Fus. (Ont.)	18	7	4		
3 A.	"	20	8	3		
3 B.	"	17	10	0		
4 B.	"	22	16	1	0	
15 B.	"	8	4	3	1	0
7 B.	F. 5. Aster Fus. (Mich.)	24	24	7	1	0
8 B.	"	26	22	13	4	3
28 B.	F. 8 Aster Fus. (Ottawa)	12	12	6	5	0
13 B.	F. 9. *F. conglutinans* (Wis.)	31	33	30	30	30
5 B.	F. 3. *Fusarium* sp.	27	22	11	3	0
6 B.	"	19	17	9	2	2
9 B.	F. 105. *Fusarium* sp.	16	10	0		
26 B.	"	18	12	2	1	0
11 B.	V.c. *Verticillium* sp.	17	17	17	15	5
11 C.	"	18	18	16	16	15
12 B.	V.a. *V. ovatum*	25	25	24	19	18
23 B.	V. 100C. *Fusarium* sp.	14	14	11	6	1
23 C.	"	20	20	17	14	6
24 B.	F. 103A. *F. culmorum*	15	14	14	14	14
2g B.	F. 103C. *Fusarium* sp.	15	14	13	13	13
27 B.	F. 7. *F. angustum*	20	12	5	1	0
27 C.	"	19	19	18	13	13
4 A.	Aster-sick Soil	21	5	2	1	0
5 A.	"	7	5	1	1	1

The St. Catharines, Michigan and Wisconsin isolations of the Aster Wilt organism were about equal in pathogenicity. *F. angustum* caused the wilt of only three out of nine plants. Plate II, B shows the re-isolation of *F. conglutinans* var. *Callistephi* from an inoculated plant. (The cabbage wilt organism *F. conglutinans* did not attack asters. Five plants wilted in aster-sick soil with only one remaining healthy after thirty days.)

Table No. 2 and Plate I, D and Plate II, show the results of the soil inoculations. In this series of tests each pot or flat was first sterilized, next inoculated with scrapings from a culture, and then aster seeds were planted.

The seed of the check in pot No. 1 B was not sterilized and the plants did not stand up as well as those in the other five checks. There was, however, a higher percentage of seed germination in this case. The Ontario isolations of *F. conglutinans* var. *Callistephi* F. 1 and F. 8 proved very virile in these tests while the Michigan strain of this fungus, F. 5, was slightly less so. This difference is probably due to the fact that F. 5 is a much older isolation than F. 1 or F. 8. The Michigan strain was isolated by Beach in 1917 and shows remarkable virility for a culture 8 years old. Various investigators have found that organisms may decrease in pathogenicity with age. Burkholder (4) found this to be the case with five year old cultures of *F. martii phaseoli.*

Fusarium conglutinans did not attack asters nor did *F. culmorum* and F. 103C. The plants wilted badly in aster-sick soil and the following forms proved to be strong pathogens:—F.3, F.105, F.100C, and *F. angustum.* In each case the same organism as used for inoculation was re-isolated from diseased plants. Neither of the strains of *Verticillium* could be re-isolated. The checks have in all cases been healthy, vigorous plants with very insignificant losses in numbers. These results have been duplicated in experiments several times. Sideris (13) has shown that in the case of pink root rot of onions many *Fusaria* are associated with the disease and that specificity of organism to host plant does not seem to exist. This also appears to be the case with aster wilt.

Four organisms were tested for pathogenicity to cabbage. The two methods of inoculation as described above were used. Results are shown in Table No. 3 and in Plate III, B. Only the cabbage wilt organism *F. conglutinans* attacked cabbage.

Taxonomic Studies

Methods

As explained above, the different cultures were purified either by repeatedly pouring dilution plates or by securing a single spore in Van Tieghem cells. The resulting strains were first studied on potato agar medium with 2% dextrose. With few exceptions normal fruiting cultures were secured on this medium and fairly complete descriptions of the different strains could be written from these preliminary studies. Strains which proved to be identical with previous isolations were discarded and dissimilar ones were kept for further study. Unnecessary work of carrying many cultures of the same fungus was thus avoided.

The organisms were studied on nine different media as listed below. The first five of these are recommended by the Fusarium conference, Wollenweber et al (17).

(1) Potato tuber cylinders (no water added).

(2) Oatmeal agar (Sherbakoff [12]).

(3) Potato agar –2% dextrose (200gms. to 1000cc.)

(4) Potato agar –5% dextrose (200gms. to 1000cc.)

(5) Rice (2gms. to 6cc. water).

Table No. 3.
Soil inoculations of cabbages.

of ...t	Inoculum	No. of Plants	Healthy Plants After 10 days	After 20 days	After 30 days	After 35 days
B.	F.9. *F. conglutinans* (Wis.)	7	6	4	1	1
B.	"	10	9	6	3	1
B.	F.1. Aster Fus. (Ont.)	12	12	12	12	12
B.	F.5. Aster Fus. (Mich.)	11	11	11	11	11
B.	Check.	8	8	8	8	8

(6) Peptone dextrose.
KH_2PO_4, 1 gm; $MgSO_4$, .25gm; $FeSO_4$, .05 gm; Peptone 20 gms; dextrose 30 gms; agar 25 gms; distilled water 1000 cc.

(7) Peptone lactose.
Similar to No. 6 except that lactose replaces dextrose.

(8) Nitrate dextrose.
Similar to No. 6 except that sodium nitrate replaces peptone.

(9) Nitrate lactose.
Similar to No. 6 except that lactose replaces dextrose and sodium nitrate replaces peptone.

The methods of study and terms used are those in general use and already described by Sherbakoff (12) and Wollenweber (16) et al (17). The writer, however, used the camera lucida for measuring spores, mycelium, etc., in a manner which he has not seen previously described.

Making Measurements with the Camera Lucida

The camera lucida is widely used for the purpose of making drawings. These drawings are often measured and the size of the object then calculated. For this purpose the amount of magnification of the image must be known. The writer has not seen any reference to a method of measurement in which the image itself is measured. This may be done by placing a suitable rule directly on the surface upon which the image is cast which is ordinarily on the drawing paper. The rule of course is free to move about and to be placed in any position. The author has used a rule with divisions in tenths and with a scale of such dimensions that one division represents one micron. A different scale is used for each of the three different objectives of the microscope. These were made by photographing a metric rule and enlarging or contracting the picture to the desired dimensions. It is easy to calculate the amount of enlargement or contraction necessary, and for this purpose a stage micrometer with divisions .1 and .01 mm. is used. The image of this scale in the camera lucida is measured and then a photograph of a metric rule is taken at such magnification that this picture will coincide with the camera lucida image of the stage micrometer. This procedure is repeated for each objective of the microscope or for only the high power and oil immersion these are the objectives most used in maki measurements. It must be remembered making these calculations from the sta micrometer that .01 mm. equals 10 micro Also changes in the position of the mirror the camera lucida change the size of t image so that the mirror must always be us in the same position. The author uses t mirror at an agle of 45° and the arm extenc practically the full extent. The same tu length of the microscope and the same e piece must always be used.

After some practice it will be found t measurements can be made very rapidly a accurately. The advantages of this meth are many. There is no changing or focus of eyepiece. Results are in microns and any multiplication by a factor is unnecessa Greater magnification can be secured, si most micrometer eyepieces magnify 7.5 tim while ordinary eye-pieces magnify up to 10 12.5 times. The method is much more ra than with the micrometer eyepiece and pr ably also more accurate. This greater acc acy is due to the fact that greater magnifi tion can be secured and that no multiply factor is used.

Behaviour of Fusaria on Different Me

Three strains of *F. conglutinans* var. *c listephi*, namely the Ontario, Michigan Wisconsin isolations and also *Fusarium* F.3 were grown on all the media listed ab None of these forms produces sporodoc sclerotia nor pseudopionnotes. Conidia produced in the aerial mycelium and usually 5% or less septate. On peptone tose and on nitrate lactose media the coni production was found to be less abundant t on the potato agars but usually from 10% 15% were septate and more curved than mal. On peptone dextrose, however, the c dial production was abundant and with c 1% to 2% septate. This is an interes example of the variability of Fusaria on ferent media. Media which contained f three to five percent dextrose tended to duce swellings in the mycelium and enlar conidia. Such swellings were not chlam spores being thin-walled and were either v olate or granular. Production of chlam spores was usually meagre on the var synthetic media. The texture of the a mycelium on peptone dextrose and on ni

dextrose was uniform, fine and cottony, while on potato agar with 2% dextrose the surface was made uneven by mycelial tufts. Some changes were noted in the growth of the aster Fusarium after it had been in culture for two years. When first isolated the colonies on potato agars usually showed patches of a moist, surface mat without aerial mycelium. As the strain became older this character was lost and the entire colony was always covered with white, aerial mycelium. Sporulation did not change with age. Burkholder (4) reports that after five years cultures of *F. martii phaseoli* change from a slimy to a white, fluffy growth.

The comparisons made by the writer between *F. conglutinans* var. *Callistephi* and *F. conglutinans* as regards taxonomy and pathogenicity agree with those of Beach (1) and Stokdyk (15).

Description of Organisms

F. 1. Fusarium conglutinans var. *Callistephi* Beach.

Conidia (Plate 11, D) 95% micro on most media, 5-13 x 2.5-5μ mostly 8-9 x 3μ; 1-septate, frequent, 18 x 4μ; 2-septate, scarce, 14 x 4 μ; 3-septate, frequent, 20-39 x 5 μ mostly 25-35 x 4; 4-septate, rare; septate conidia, sickle-shaped, with the stronger curve toward the apex, which is gradually attenuate; sub-pedicellate.

Chlamydospores; abundant on most media, single mostly or double, terminal or intercalated 8-12 μ.

Sclerotia, sporodochia and pionnotes absent.

Aerial mycelium white, cottony, well-developed on most media, but sometimes lacking in patches.

Substratum salmon on rice. No color on most media.

Resembles *F. conglutinans* Wr. from which it differs in pathogenicity and in having slightly shorter micro and macro conidia.

Causes wilt, stem and root rot of asters in Ontario.

Fusarium sp. (F 3)

Conidia; (Plate II, D) 90% micro on most media, 7-13 x 2¼-4½ mostly 9 x 3; 1-septate, frequent, 14-22 x 3-4; 2-septate, few, 22 x 3½; 3-septate, frequent, mostly 30-40 x 3½-4½; 4-septate, few, 42 x 4; Septate conidia same shape as *F. conglutinans*.

Chlamydospores single mostly or double, also in chains of 3 or 4; 5-12μ in diameter.

Sclerotia, sporodochia and pionnotes absent.

Aerial mycelium poorly developed but very strong and rapid surface grower.

Substratum salmon on rice.

Resembles *F. conglutinans* but has narrower conidia, smaller chlamydospores which occur frequently in chains on potato agar and surface loving habit.

Causes wilt of asters at Brandon, Manitoba.

Fusarium sp. (F 105)

Conidia (Plate III, A) micro 80-90%; 6-11 x 2-3½ (8x2½) 1-septate 18 x 3½; 2-septate 32 x 3¼; 3-septate 35-50 x 3½-5 mostly 42 x 4½; 4-septate, scarce, 40-58 x 4½; septate conidia sickle-shaped, sub-pedicellate, apex gradually attenuate.

Chlamydosphores single 7-13 μ, double 8 x 20 or in chains and clumps; terminals or intercalated; wall more or less uneven, conidial chlamydospores single or double, 7μ in diameter.

Sclerotia absent.

Minute sporodochia and pseudo-pionnotes present, moist, light vinaceous-cinnamon in color.

Aerial mycelium white, moderate in amount, often collapsing and becoming same color as pseudo-pionnotes.

Causes wilt of asters at St. Catharines.

Fusarium sp. (F 100C)

Conidia, only micro present 6-8 x 2-2¾ ovoid to cylindrical.

Chlamydospores single 7-11 μ, double or in chains. Irregular rough wall.

Aerial mycelium well developed, white and cottony.

Causes wilt at St. Catharines.

Fusarium Angustum Sherb. (F 7)

The strain which was given this name agrees very closely with Sherbakoff's description of this species (12).

Pathogenicity in Relation to Temperature

An experiment was set up to compare rate of wilt under warm against cool conditions. Some of the pots were set in a cool part of the greenhouse protected from the heat, and where the soil temperature was between 17° and 20°C. Other pots were placed on boards directly above the hot water pipes where the soil temperatures averaged 20° to 25°C. Results are shown in Table No. 4. Very little wilt occurred at the lower temperature, while

Table No. 4.
Pathogenicity under warm and cool conditions.

Inoculum			Healthy Plants Jan. 10	Jan. 20	Jan. 30
F.1.	Aster Fus. (Ont.)				
		A-warm 20-25°C.	12	11	6
		"	10	5	3
		B-cool 17-20°C.	6	5	5
		"	6	6	4
F.4.	Aster Fus. (Wis.)	A-warm	3	2	0
		B-cool	5	4	3
		"	2	2	2
F.5.	Aster Fus. (Mich.)	A-warm	11	9	6
		B-cool	6	6	5
		"	6	5	5
Aster-sick soil		A-warm	3	3	0
		B-cool	6	5	5
		"	2	2	2
Check		A-warm	9	9	9
		B-cool	6	6	6
		"	9	9	9

75 to 100% of the plants wilted at 20° to 25°C. Check plants were healthy at both temperatures. A duplication of this experiment showed similar results.

It has often been observed by aster growers, also by Beal (2) and by the author that early asters suffer more from wilt than late asters. This is not considered to be due to a varietal difference in susceptibility but rather due to the time of blooming. Since higher temperatures favor wilt the amount of infection should be higher during the summer months than in the fall. A plant in full bloom or about to bloom is doubtless less able to withstand an attack of wilt than one less mature and consequently it is those plants which are mature at this critical time that suffer most. Gilman (5) found that cabbage yellows showed up in the greenhouse in flats kept at 25°C. and not in those kept at 15-20°C. The critical temperature was determined to be 17°C. MacMillan and Merkstroth (10) found 14°C. to be the critical temperature for the infection of potato tubers by *F. oxysporum* Schlect. These authors also cite other Fusaria with definite temperature relations.

Pathogenicity in Relation to Type of Soil

In all the foregoing tests a rich loam soil was used. In this experiment a comparison was made between the amount of infection in loam, clay and sand. Extra humus in the form of sheep manure was added in some cases. Results are shown in Table No. 5.

Wilt was most severe in loam soil; almost equally so in the clay soils; while in sand the infection was slower and a few plants always survived. The addition of humus tended to

Table No. 5.
Infection in different soils.

No. of pot.	Soil	Treatment of Soil	No. of Plants	Healthy Plants After 10 days	After 20 days	After 30 days
1.	Sand	(Check, no humus)	20	20	20	19
2.	"	(Inoc., " ")	20	10	4	4
3.	Clay	(Check, " ")	14	14	13	12
4.	"	(Inoc., " ")	7	4	3	0
5.	Sand	(Inoc., & Humus)	63	50	13	3
6.	Clay	(Inoc., & Humus)	59	31	6	0
7.	Loam	(Check)	20	20	20	20
8.	"	(Inoc.,)	31	17	6	0

Table No. 6.
Seed and Soil inoculated in all flats.

No. of Flat	Treatment of Seed	Treatment of Soil		Healthy Plants May 28	June 10	Sept. 23
1.	None	None		72	66	7 (stunted)
2.	None	$HgCl_2$	1-1000	114	114	18
3.	$HgCl_2$, 1-1000, ½ hr.	$HgCl_2$	1-1000	123	123	25
4.	$HgCl_2$. 1-1000, ½ hr.	None		103	93	11 (stunted)

EXPERIMENT 2.

Table No. 7.
Seed Treatments Tests.

No. of Pot	F. 1 Inoculation	Seed Treatment	Healthy Plants Dec. 30	Jan. 27	Feb. 12	Feb 27
1.	None	None.	39	39	38	38
2.	Seed only	None.	50	31	22	14
3.	Seed and soil	None.	54	20	6	5
4.	Seed only.	$HgCl_2$. 1:1000	38	43	39	36
5.	Seed and soil.	$HgCl_2$. 1:1000	46	30	9	5
6.	Seed only.	Bayer Compound .25%	43	29	16	13
7.	Seed and soil.	" " "	62	34	10	8
8.	Seed only.	Bayer Dust	54	39	27	14
9.	Seed and soil.	" "	49	24	9	4
10.	Seed only.	Uspulun .25%	56	56	54	52
11.	Seed and soil.	" "	46	25	2	2

ıcrease the severity of wilt both in the case f sand and clay. The disease was very severe ı all cases, however, and the difference due soil type appears to be too small to be of ıy practical importance. This experiment as duplicated with similar results.

Experiments in Control

XPERIMENT 1. SEED AND SOIL TREATMENT TESTS.

Four flats were used in this experiment ıth seed and soil being inoculated in all ses with the Ontario isolations of *F. conglu-ıans* var. *Callistephi.* Two hundred seeds re planted in each flat on May 9th. Mer-ric Chloride 1-1000 was used to treat seed soil of the different flats as shown in Table). 6. Results of the experiment are also own in this table and in Plate III, D.

The flats were too small for the number of ants which came up and crowding resulted the loss of many seedlings. The good owth and fine bloom of the remaining ants, however, in flats two and three show at the wilt was held in check fairly well by aking the infested soil with a 1-1000 solu-n of Mercuric Chloride. Seed disinfection ne as in Flat No. 4, did not materially reduce the losses, since the organism was already present in the soil. This experiment shows that in such cases the soil as well as the seed must be treated.

EXPERIMENT 2. SEED TREATMENT TESTS

In this experiment Mercuric Chloride, Bayer Compound, Bayer Dust and Uspulun were tested for efficiency as seed disinfectants. These four materials were each used to treat two different lots of one hundred seeds each of asters. These seeds had been previously inoculated in a spore suspension of *F. conglutinans* var. *Callistephi.* The seed disinfection treatments were for one half hour at the fol lowing strengths.

Mercuric Chloride—1:1000
Bayer Compound —.25% solution.
Bayer Dust —a quantity equal to the volume of the seed.
Uspulun —.25% solution.

After treatment one lot of each seed was sown in a pot of sterilized soil while the other lot was planted in a pot of soil which had been first sterilized and then inoculated with the aster wilt Fusarium. Results are shown in Table No. 7, and Plate 111, C.

Pots 1, 2, and 3, of this experiment show that when inoculated seed is planted in clean

soil such severe losses are not experienced as when both soil and seed are infested with organism. Pots 4 and 10 show that where seed has been inoculated, then treated with Mercuric Chloride 1:1000 or Uspulun .25% solution and then planted on clean soil, no disease results. Pots 5 and 11 show that where seed has been treated in this manner and then planted on inoculated soil wilt is very severe. This experiment agrees with experiment 1 in the conclusion that seed disinfection does not prevent wilt on infested soil.

Selection of Asters Resistant to Wilt

Throughout the previous experiments it has been noticed that individual plants in pots or in flats seemed to withstand inoculation. Such plants were apparently resistant to wilt and wherever possible these were allowed to mature and to produce seed. In 1925 one hundred and ninety-eight seeds were collected. In January, 1926, one hundred of these seeds were sown in pots containing inoculated soil and the remainder in aster-sick soil. The plants have stood up much better than those from commercial seed under the same conditions. This work is being continued.

Asters are almost entirely self fertilized and when a resistant strain has once been secured the quality should remain in the plants fairly constant from one generation to another. Resistant varieties are very desirable and doubtless this means must finally be depended upon to control wilt. *F. conglutinans* var. *Callistephi* is a soil organism and exists already in many localities where soil sterilization is impracticable. Under such conditions the only alternatives are a long period of rotation or resistant varieties. Jones and Gilman (7) and also Jones, Walker and Tisdale (8) have been able to select strains of cabbage resistant to yellows and such strains are now largely used commercially in areas where cabbage-sick soil is prevalent.

Studies in Reaction

F. conglutinans var. *Callistephi* and *F. conglutinans* were studied on potato agar with 2% dextrose at reactions of -30, -20, -10, 0, +10, +20, and +30 Fuller scale. It was found that growth was normal and good on all cultures with the exception of +30 where the growth was slower at first but later about equal to that of the others. Conidial production was equally abundant in all tubes.

Control Recommendations

That present control measures are very un certain is shown by the following extra taken from the catalogue of a prominent see firm. This recommendation advised tha "when yellowing occurs in asters, apply lim wood ashes, and salt to the land for ne year." In Beach's (1) paper on the subje of Fusarium Wilt of China Aster a chapter devoted to control, which part was contribute by Prof. G. H. Coons. The chief measur suggested are (1) seed disinfection, (2) us of clean soil for flats or seed bed, (3) sanitar measures in the field, and (4) home grow seed selected from healthiest plants. Thes same four headings will be used in the prese discussion of control.

(1) Most growers of aster seed now disinfe their seed for one-half hour with 1:1000 Me curic Chloride before selling it. This info mation is contained in letters to the write from several large commercial growers c aster seed. Seed disinfection protects th seedlings and prevents the introduction to th soil of the wilt or other disease-producing o ganism. This is most important from th standpoint of future crops. According t Gloyer (6) the following fungi causing aste diseases are seed-borne and are controlled b seed treatment, namely:—*Botrytis cinerea*, *Ascochyte Asteris*, *Fusarium* sp. and *Septori Callistephi*. Aster seed should be treated i the manner stated above if it is not definitel known that this has already been done.

(2) Experiments show that the wilt o ganism is very destructive to seedlings. I asters are started indoors, it is profitable t disinfect the soil of the seed bed. Stean sterilization is most effective but Mercuri Chloride 1:1000 or Formaldehyde, one par to fifty parts of water, may be used. If wi or damping-off should appear in the seed-be it may be checked by keeping the temperatur below 20°C. and by treating the flats with 1:2000 solution of Mercuric Chloride.

(3) Wilted plants and also those showin "Yellows" should be pulled and burned wher ever they appear. At the end of the seaso all crop refuse should be burned because suc refuse may be full of disease-producing or ganisms. Sterilization will cure aster-sic soil. It is of course impracticable to trea large fields but small beds of limited size i gardens can no doubt be made safe for asters Formalin 1:50 is probably best suited fo

treating such soil. The earth should be spaded over to a depth of about 10 inches and at the same time thoroughly wet with the solution. It should then be covered for a day with blankets or sacks which have also been soaked in the formalin solution. After treatment the soil cannot be planted for a week and it must also be spaded over three or four times for aeration.

(4) It has been found in experiments that individual plants are resistant to wilt and that seed from these plants also seems to possess this quality. The author hopes to build up resistant strains of asters by repeated selections. Aster growers who have wilt in their aster beds purposely avoid taking seed from any of these plants, and yet it is just possible that those plants which do bloom satisfactorily under such circumstances are the ones which produce the kind of seed most desired.

Summary

1. Aster wilt is very prevalent in Ontario nd in many gardens the soil has become aster-ick.

2. All varieties of asters are susceptible to vilt.

3. Yellows and aster bug injury are entirely ifferent from wilt and their symptoms are escribed. Both are abundant in Ontario.

4. *Fusarium conglutinans* var. *Callistephi* each has been isolated many times from wilt-d asters and is the usual cause of the disease Ontario. This organism is not pathogenic cabbage. Four other *Fusaria* sp. isolated om aster proved to be strong pathogens.

5. *F. conglutinans* Wr. did not attack aster, ut caused cabbage yellows.

6. An additional use of the camera lucida r making measurements is described. It nsists in measuring the image with a rule hich gives the results directly in microns.

7. Variations in the cultural characters of e different strains of Fusaria are noted when own on different media. On Nitrate dex-ose and on Nitrate lactose the percentage of septate conidia of *F. conglutinans* var. *Cal-tephi* is much higher than on other media. is same Fusarium sp. becomes more aerial habit with age.

8. Descriptions are given of the pathogenic forms.

9. A temperature of 20° to 25°C. was found favorable, while 17° to 20°C. was unfavorable to wilt.

10. Aster wilt was almost equally severe on clay, sand and loam soils.

11. When seed alone is inoculated with the organism and the soil is clean the losses from wilt are small compared to losses in the case where the soil as well is infested. Mercuric Chloride 1:1000 and Uspulun .25% for one half hour are effective seed disinfectants. Seed disinfection will not prevent wilt nor appreciably reduce it if the organism is already present in the soil. Seed disinfection, however, prevents the introduction of pathogenic organisms to an otherwise clean soil and controls wilt on such soil.

12. Aster-sick soil can be made safe for asters by thoroughly soaking with 1:1000 Mercuric Chloride. This may be done at the time the seed is planted.

13. Seed has been secured from resistant plants and has stood up better than commercial seed when planted in inoculated and in aster-sick soil. Further work should result in strains of asters definitely resistant to wilt and this means must be depended upon finally to control the disease.

14. *F. conglutinans* and *F. conglutinans* var. *Callistephi* both have a wide tolerance for acidity ranging from —30 to +30 Fuller scale.

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PLATE I.

A. Aster plant affected with yellows. Note upright habit and deformed flowers.
B. Aster plant affected with yellows and also the stunted bushy growth shows typical aster bug injury.
C. A wilted mature aster plant.
D. Flat No. 3 A. (See Table No. 2.) Three plants surviving twenty days after inoculation.

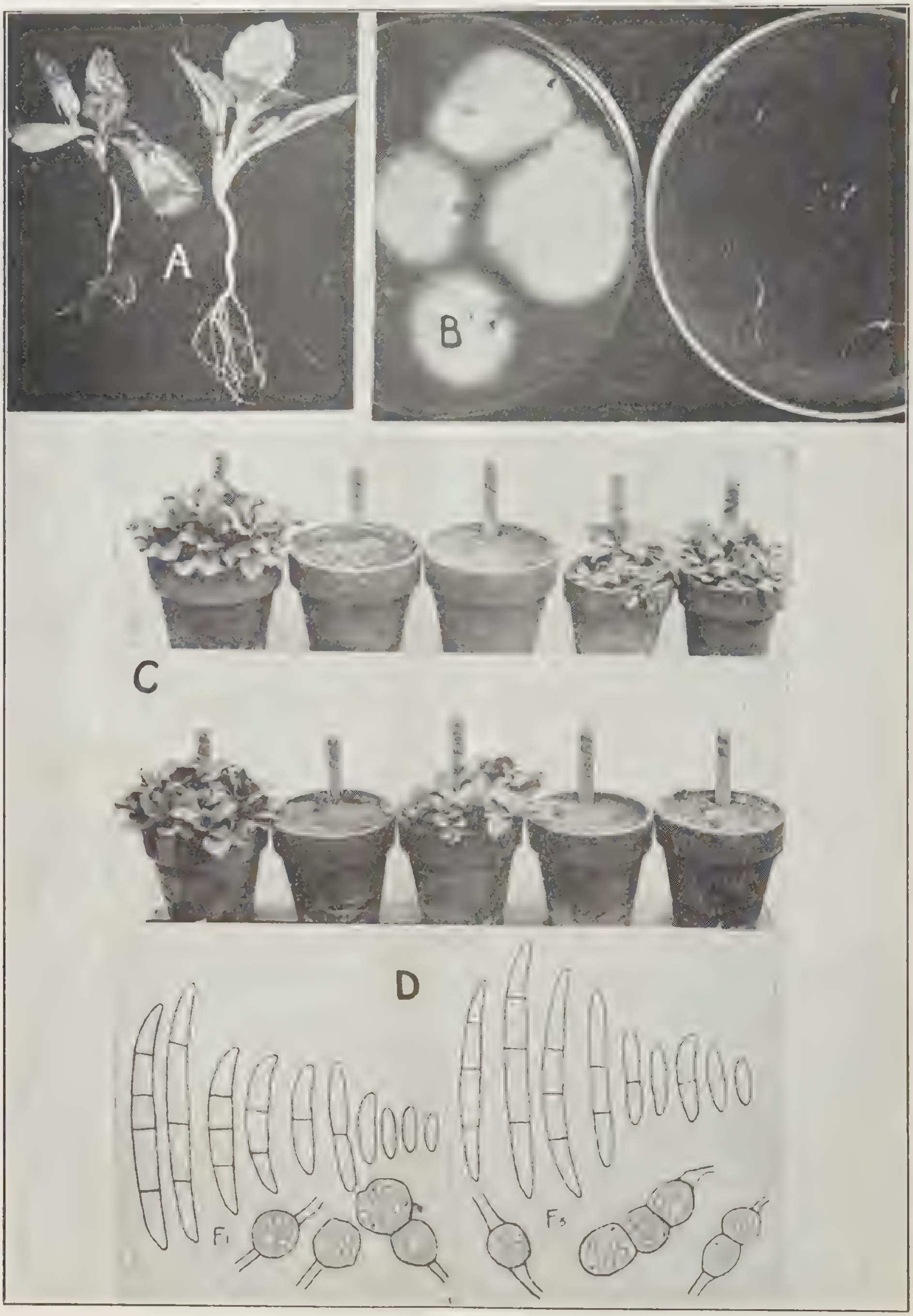

PLATE II.

A. Diseased plant (inoculated) and a healthy one (check).

B. Results when the same two plants as shown in A. are plated on agar in petri dishes. The aster wilt fungus grew from the pieces of the diseased plant while there was no growth from the pieces of the healthy plant.

C. From Table No. 2. Thirty days after inoculation with various organisms.

D. Conidia and chlamydospores of *F. conglutinans* var. *Callistephi* and of *Fusarium* sp. F.3.; X 1000.

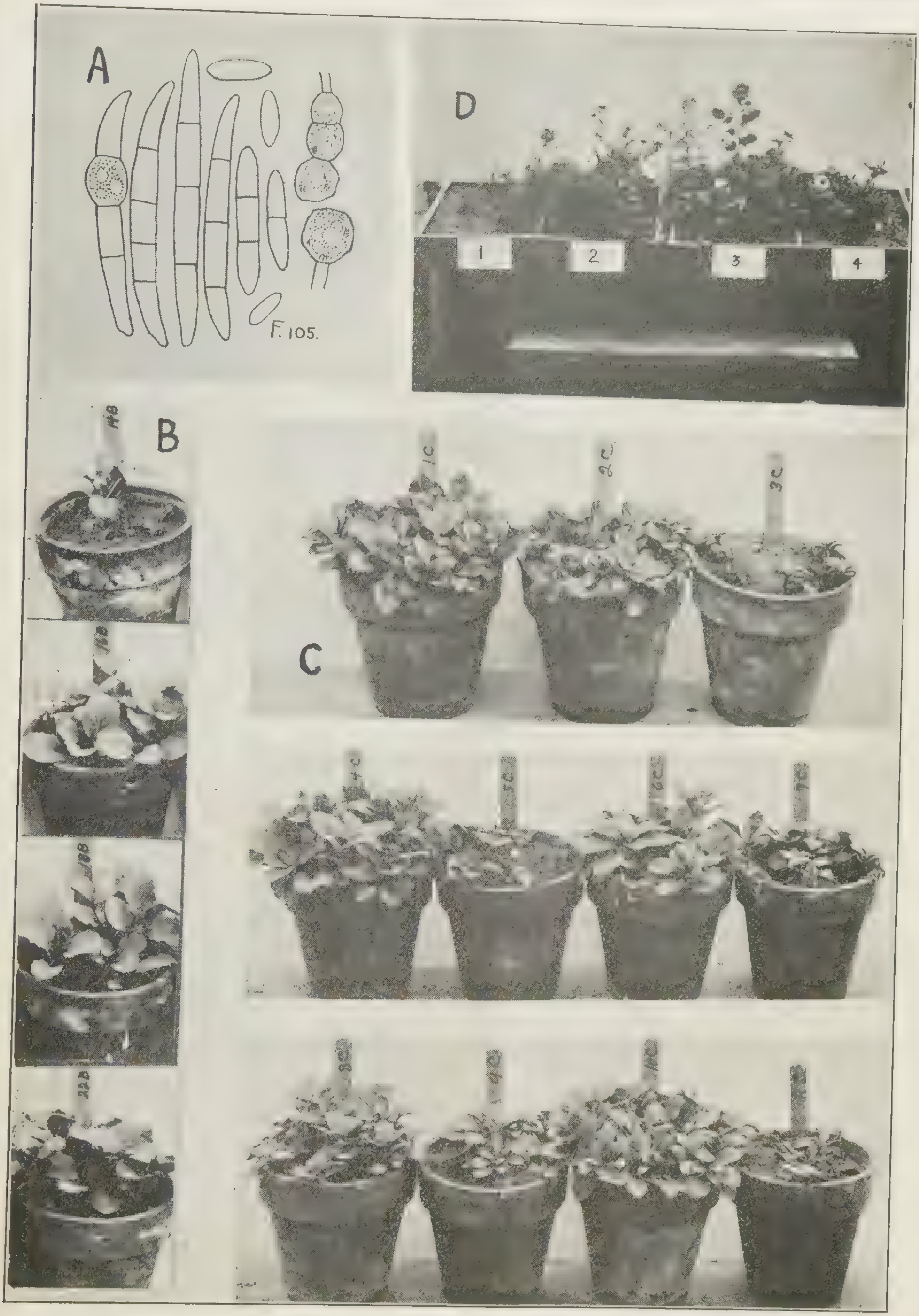

PLATE III.

A. Conidia and chlamydospores of *Fusarium* sp. F. 105, X 1000.

B. Cabbage inoculated with various organisms. Numbers on the pots correspond with those in Table No. 3. Only *F. conglutinans* attacked cabbage (pot No. 14B.).

C. Results of Control Experiment 2. Numbers on pots correspond with those in Table No. 7.

D. Results of control Experiment 1. Numbers on flats correspond with those in Table No. 6.

Variation in Plot Yields Due to Soil Heterogeneity.*

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In general the various plots within every experimental field will show some variation in crop yields. Furthermore, it is almost universal that such variations in yields from plots within the same field are significant in that they show differences in yields greater in magnitude than could be attributed to chance.

Some of the factors responsible for this variation in plot yields may be mentioned as follows; heterogeneous character of soil, seasonal influence of climate, size and shape of plots, distribution of checks, uniformity of seed.

It is reasonable to expect that the relatively more fertile plots will consistently outyield the less fertile plots, and to minimize this known difference in the inherent productive power of different plots most experimental fields have been chosen so as to embrace apparently uniform areas. But despite this apparent uniformity in soil the fact remains that different plots give different yields both for the same crop in different years and for different crops from year to year.

After a very thorough review of the literature in which 22 papers are cited Harris (3) concluded that the fields upon which plot tests have been conducted are practically without exception so heterogeneous as to influence profoundly the yields of the plots.

Unfortunately the literature contains relatively but a meagre amount of data on this important subject and most of this has been published since 1910. The above statement is not intended as a criticism of the earlier investigators, who in practically every case very carefully selected the most uniform areas available for experimental purposes. However, we can not help but express a regret that more of the older experimental fields were not subjected to performance tests for a period of years before the rotation and fertilizer experiments were begun. In only a few instances do we find records of such preliminary performance tests and in these cases the data include yields only for one, two, three years.

Review of Literature

Wheeler (11) states that some plots Rhode Island were subjected to a legume a then to corn in successive years in order determine the uniformity before any fertil ers were applied. The abnormal plots we to be discarded. After applying fertilize for a number of years it was found th similarly treated plots gave rise to differe responses from the different crops. This l to a new plan to study the variability in pl by studying the effect of the growth of a giv variety of plant upon other plants which we to follow. The experiment consisted of plots. On each plot a different crop was be grown for two successive years, follow by a blanket crop on all plots. This was be followed by the original crop for two co secutive years after which all plots were produce the same blanket crop. Such experiment would require thirty years complete it.

Lehmann (5) reports yields of paddy a ragi for three consecutive years (1905-190 at Mysore in experiments attempting to st dardize the productivity of the various pl He used one-tenth acre plots, and found gr fluctuations both as regards individual pl and seasonal influences.

Morgan (9) discusses some experime from Cornell showing the great variation plots when wheat and corn (fodder) w grown the same year on the same plots a other experiments where timothy was gro three consecutive years. The wheat and c experiments consisted of 63 plots 112½ f x 15 feet. Wheat was seeded in the fall 1907 and harvested the middle of July 19 The land was immediately plowed and pla ed to fodder corn which was harvested Se 28. The relative maximum variations w wheat 65 to 130 and corn 35 to 192 when mean is taken as 100. Timothy Fertilizer periments for the years 1905, '06 and

*Paper read before Western Canadian Society Agronomy, December, 1926.

showed maximum relative variations from 10 to 139 above the checks. The rank in productiveness for the individual plots had a tendency to change from year to year when producing timothy either when fertilized or unfertilized.

Smith (10) reports yields for corn grown three consecutive years on 120 tenth-acre plots at Illinois. The land had been in pasture for 16 years and was broken in 1895 when it was seeded to corn. It again produced corn in 1896 and '97. No fertilizer treatment was applied during these three years. The following tabulated statements shows the relationship in deviation for the three years.

Year	Mean	P.E.	S. Deviation	P.E.
1895	30.62	1.45	7.00	1.32
1896	94.06	1.30	4.73	1.21
1897	72.43	1.22	3.58	1.16

The per cent. deviations from the mean are ;espectively 22.86, 5.03, and 4.94 for the hree years. This suggests that continued ropping tends to induce uniformity. However, Smith states that some of the plots were ropped to corn for the next three years conecutively and did not support the above conlusion. The extreme variation in yields for he three years was found to be respectively 3 bushels, 23 bushels and 16 bushels. "Plots ving adjoining showed the following maxiium variation:—1895, 18 bushels; 1896, 11 ushels; 1897, 8 bushels."

Lyon (6) reports results for seven years Nebraska. There were 24 twentieth-acre lots and the crops grown were corn, oats, id wheat. No fertilizer except manure was pplied. Results are also included for potaes, one year (1909) and corn, one year 911) at Cornell. His results indicated hat it is not possible to establish a schedule relative yields for a series of plots, even ter several years comparison." Referring variety tests he says, "The character of the ason in which a variety test is conducted ay affect the results through the ability of certain variety to withstand drought or exssive moisture or to flourish under excessive at or continued low temperatures."

Kiesselbach (7) reports yields from Neaska which show great variation from plot plot. Weiner's (12) results from Mania from 94 one-hundreth acre plots produc- Mindum wheat in 1924 also show great t variability as well as do those of Garber (1) for oats (1924), and wheat (1924) from West Virginia and those of McClelland (8) for oats and corn (1925) from Arkansas.

The most extensive data thus far reported are those by Harris (2) showing yields from an irrigated experimental field at Huntley, Mantana for nine years (1911-1919) and including sugar beets one year, alfalfa three years, corn two years, oats one year and barley one year. These experiments consisted of 46 plots each containing .17 acre. The plots had received no treatment and the land was relatively in its virgin state, only having been broken from native sod in 1908.

All of the above investigators draw attention to the decided heterogeneous character of the plots. Some of them find no correlation in yields from year to year whereas others find an inter-annual correlation in the yields from the same plots. Harris (2) has made inter-annual correlations for the same crop and for different crops using data from his own experiments as well as data reported by the above mentioned investigators. He concludes from such statistical studies that there is decided inter-annual correlation. His conclusions may be stated as follows: plots showing high yields one year will tend to give high yields in subsequent years with the same crop or with different crops.

Harris (2) points out that of the 152 correlations between the yields of plots in the different years 133 are positive (+ 0.335) while 19 are negative (— 0.148), and the general average is + 0.274. The correlations between the yields of each individual crop and the yields on the same plots during the nine years are on the average positive with the exception of the sugar beet crop in 1911. However, he further states—"It is probably not a principle of universal applicability, because of the fact that meterological as well as soil conditions play a large part in determining yield. It is quite probable that certain soil characteristics would result in maximum yields with one set of meterological conditions, but in minimum yields with an other complex of aereal conditions."

From the above review of the literature it would seem that universally there is a heterogeneous soil condition influencing the yields from the various plots within any experimental field and that seasonal influences also have very great effect upon the relative yields from plots. Limited moisture supply especially during the growing season is one of the

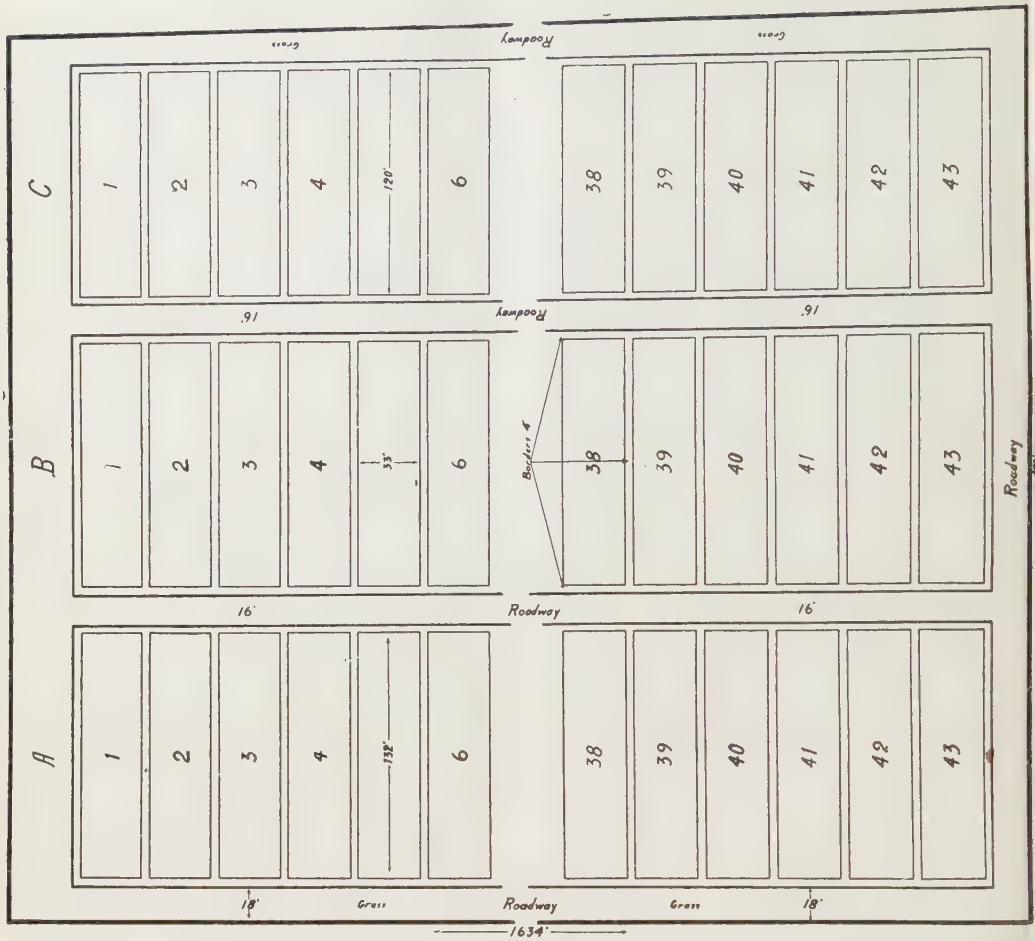

FIG. 1—Plan of Soils Experimental Field, University of Alberta.

greatest factors affecting variations in plot yields. This is clearly shown by experiments reported by Harris (4) and Butt from Utah where dry farm and irrigation systems of farming are compared. Their paper includes data for the following crops; potatoes, sugar beets, corn, oats, wheat and alfalfa. The various crops were grown for periods varying from nine to fifteen years. The conclusions drawn from these experiments are in part as follows:—"all treatments in an experiment are not affected relatively the same each season; the amount of divergence varies in different years.

"Under dry-farming conditions variations are wider than under irrigation conditions and small irrigations vary more than whe the plant does not suffer for water.

"In these experiments potatoes varied yield most, followed in order by sugar bee alfalfa, corn, oats and wheat."

Many of the papers above referred to we not published at the time when the plans the Soils Experimental field at the Univers of Alberta were being formulated, but t variability in the productive power of indiv ual plots had been recognized by past perience, and it seemed reasonable that possible precaution should be taken to sec the most reliable returns from our expe mental plots. Thus it was decided to s ject all the plots in the field to performa

tests by using blanket crops for a sufficient number of years to make it possible to group the rotations and treatments according to the productivity of the plots.

History and Plan of Field

The Soils Experimental field was transferred from the Animal Husbandry Dept. to the Soils Dept. in the fall of 1922. The field has the following dimensions: 476 feet by 1634 feet with the long dimensions running north and south and consisting of a little less than 18 acres. The land was originally covered with a medium growth of poplar (1 to 6 inches in diameter) interspersed with willows similar to most of the virgin land in the Edmonton district. It was first cleared of bushes and trees in 1921 and the early part of 1922. The land was broken in 1922 and the tree roots cleared and burned. In the spring of 1923 the land was prepared and seeded late in the season to oats for green feed. Owing to shortage of labour the first crop which this land produced was pastured off late in the fall of 1923. In the spring of 1924 the land was prepared and Victory oats seeded (May 8 and 9) at the rate of 3 bushels per acre. Owing to the lack of facilities it was impossible to harvest this crop as individual plots, and the entire field was harvested as a unit. The average yield of oats per acre was 73.25 bushels. Victory oats were again seeded May 15, 1925, at the rate of 3 bushels per acre and were harvested Sept. 1, as individual plots (1/10 acre) after removing the border. The average yield per acre this year was 88 bushels. The land was plowed in the fall of 1925 and in the spring of 1926, Marquis wheat was seeded (April 22) at the rate of 2 bushels per acre. This crop was harvested as individual plots on Aug. 17 and 18. The average yield of wheat was 32.2 bushels per acre. Yields of oats (1925) and wheat (1926) for the 124 individual plots are recorded in Table 1. The relative yields are likewise plotted as curves in Figs. 2 and 3.

Some idea of the plan of the field may be had by referring to Fig. 1. The field is laid off in three series extending north and south. Series A is on the west side of the field and Series C on the east side. There is a grass border 18 feet wide around the entire field and a similar border 16 feet wide between each series. Series A and B each consists of 43 plots, 140 feet by 37 feet, while Series C consists of 43 plots, 128 feet by 37 feet. There is a border 4 feet wide between each plot, and a border 4 feet wide at each end of each plot. These borders are removed be-

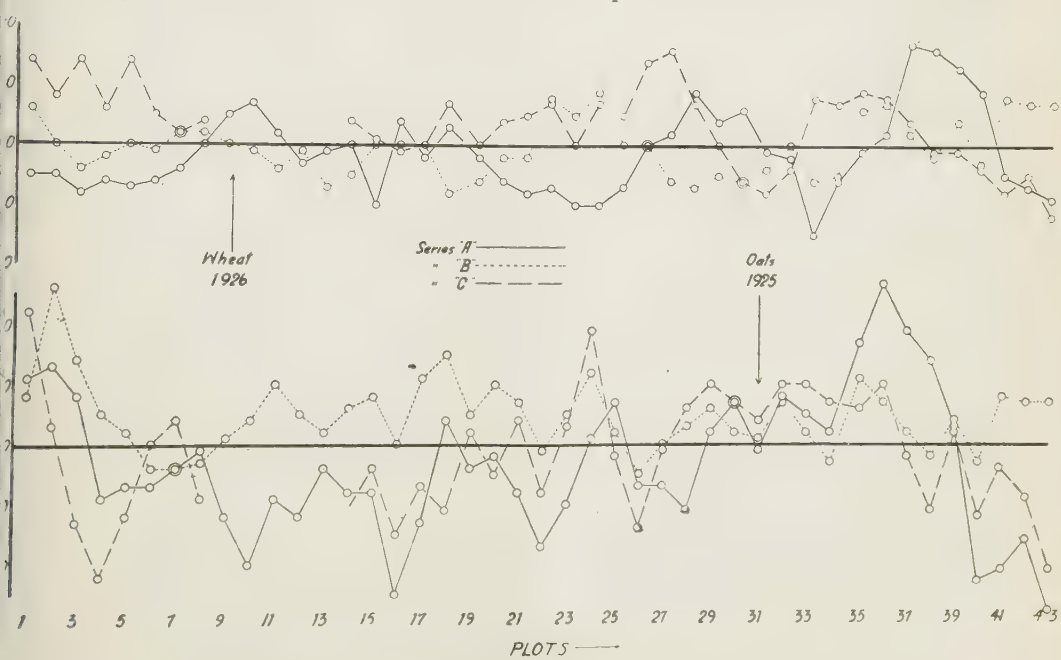

FIG. 2—Relative plot yields of oats, 1925 (lower graph) and wheat, 1926 (upper graph) 100 = mean for 124 plots (88 bushels of oats, or 32.2 bushels of wheat)

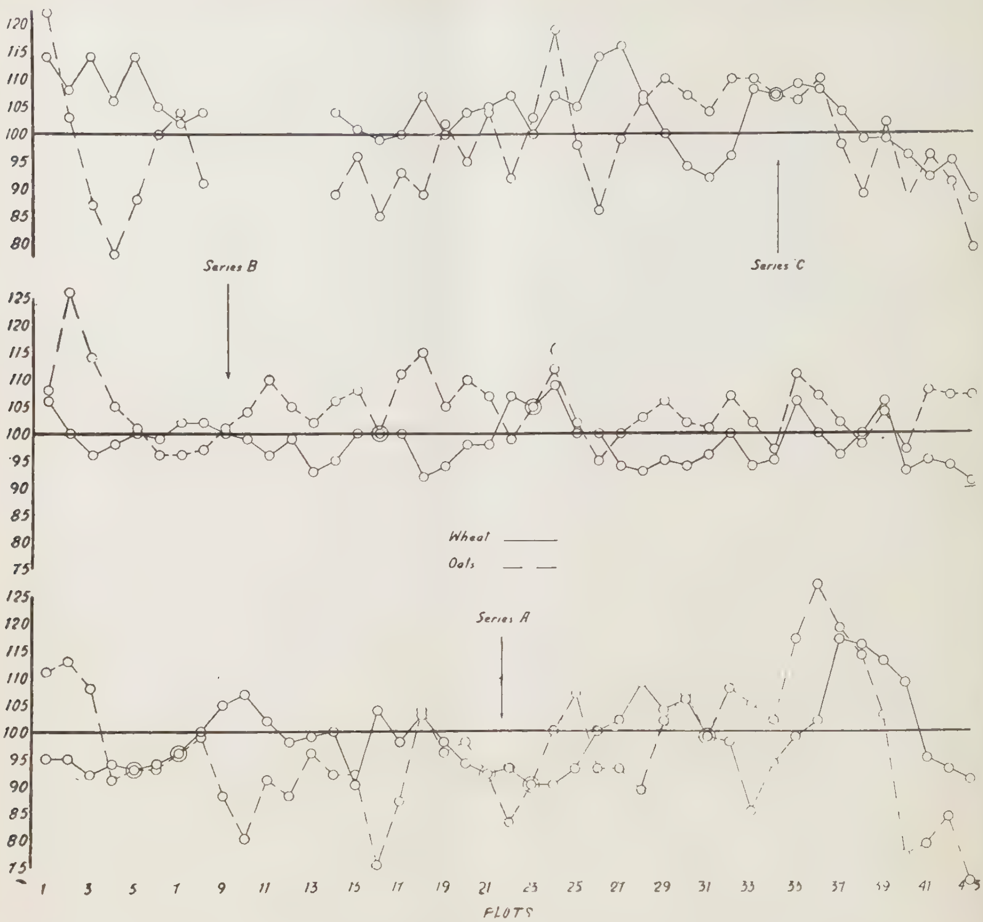

Fig. 3—Relative yields of oats (1925) and wheat (1926) from various plots in series A, B, and C, 100 = mean for 124 plots.

fore harvesting the plots, leaving a net area of 1/10 acre (132 x 33 feet) for each plot in Series A and B and 1/11 acre (120 x 33 feet) per plot in Series C.

The soil of the field apparently is not absolutely uniform despite the fact that it is all relatively fertile. However, it is apparently as uniform as any area of similar size in this part of Alberta. There is a general gradual slope to the west and south with a difference in elevation between the highest and lowest points of about six feet. The soil is a heavy black loam characteristic of the better soils of the Edmonton district. A general description of the soils of this district may be found in previous papers (13), (14), one (14) of which contains a tabulated statement of the composition of soils from nearby fields (Campus and Experimental Fields).

The data presented here are intended only as a progress report. Final conclusions must await the returns of at least several more years. However, it is hoped that these data will impress the value of the necessity for systematic performance tests for plots which are to be used as rotation, fertilizer or variety yield experiments and act as a restraint from temptations to draw sweeping conclusions regarding fertilizer or variety yields from the results of a limited number of especially small plots and a limited number of years.

The land had never been cropped previous to 1923. In 1923 and 1924 blanket crops of oats were grown on all the plots, but owing to the scarcity of help it was impossible to harvest these crops as individual plots. The crops in 1925 and 1926 were thus respectively the third and fourth crops that had been pro-

duced after the land had been cleared and broken from its virgin condition.

Table I contains data for the relative yields from 86 tenth-acre and 38 eleventh-acre plots all cropped to Victory oats in 1925 and all to Marquis wheat in 1926.

(Table I)

Table I—Relative Yields of Victory Oats (1925) and Marquis Wheat (1926) on Unfertilized Plots, Edmonton, Alberta.
100—mean for 124 plots (88 bushels of oats, or 32.8 bushels of wheat per acre)

'ot	SERIES A		SERIES B		SERIES C	
	Oats	Wheat	Oats	Wheat	Oats	Wheat
No.	1925	1926	1925	1926	1925	1926
1	111	95	108	106	122	114
2	113	95	126	100	103	108
3	108	92	114	96	87	114
4	91	94	105	98	78	106
5	93	93	101	100	88	114
6	93	94	96	99	100	105
7	96	96	96	102	104	102
8	99	100	97	102	91	104
9	88	105	101	100	---	---
0	80	107	104	99	---	---
1	91	102	110	96	---	---
2	88	97	105	99	---	---
3	96	99	102	93	---	---
4	92	100	106	95	89	104
5	92	90	108	100	96	101
6	75	104	100	100	85	99
	87	98	111	100	93	100
	104	103	115	92	89	107
	96	98	105	94	102	100
	98	94	110	98	95	104
	92	92	107	98	104	105
	83	93	99	107	92	107
	90	90	105	105	103	100
	101	90	112	109	119	107
	107	93	102	100	98	105
	93	100	95	100	86	114
	93	102	100	94	99	116
	89	109	103	93	106	107
	102	104	106	95	110	100
	107	106	102	94	107	94
	99	99	101	96	104	92
	108	98	107	100	110	96
	105	85	102	94	110	108
	102	94	97	95	107	107
	117	99	111	106	106	109
	127	102	107	100	110	108
	119	117	102	96	98	104
	114	116	98	100	89	99
	103	113	104	106	102	99
	77	109	97	93	88	96
	79	95	108	95	96	92
	84	93	107	94	91	95
	72	91	107	91	79	88

andard deviation for oats—
312 lbs. per acre= 10.43%
andard deviation for wheat—
124 lbs. per acre= 6.43%
orrelation coefficient
for oats and wheat=.08±.089

The yields in the table are relative and are reported on the basis of the mean for the 124 plots being 100. In the case of oats this is 88 bushels per acre while for wheat it is 32.2 bushels per acre. No decimals are used in the table, the figures being reported to the nearest whole number only. It will be observed that no yields are reported for plots 9 to 13, series C. These plots were devoted to cultivation and moisture experiments in 1924 and 1925. In 1926 they produced wheat.

Expressed as bushels per acre the extreme variation in the yield of oats for the year 1925 was 48.6 bushels. (plots 36 and 43, series A) Plot 36 yielded 27 per cent. above the mean while plot 43 yielded 28 per cent. below the mean. This makes a variation of 55 per cent. The extreme variation in the wheat yields for 1926 was 10.4 bushels (plots 37 and 33, series A). Plot 37 yielded 17 per cent. above the mean while plot 33 yielded 15 per cent below the mean. This makes an extreme variation in the wheat yields of 32 per cent as compared with an extreme variation of 55 per cent. for the oat crop of the previous year. (see Fig. 2).

The greatest variation in yields for plots lying adjacent was 22.9 bushels for oats (plots 39 and 40, series A). Plot 39 yielded 3 per cent. above the mean while plot 40 yielded 23 per cent. below the mean, making a total of 26 per cent. of the mean as the difference in yields between these two adjacent plots when they were producing the same variety of oats.

By making similar comparisons for the wheat we find plots 36 and 37, series A, showing a difference of 4.9 bushels. Plot 36 yielded at the rate of 2 per cent. above the mean while plot 37 yielded at the rate of 17 per cent. above the mean, thus giving a total difference equal to 15 per cent. of the mean when these two adjacent plots were producing the same variety of wheat.

Now in so far as the variations in the oat yields from plot to plot are concerned, and similarly for the wheat yields, these variations may rightly be attributed to the heterogeneity in the soil, since the oat yields were all produced under the same climatic conditions in 1925, and the wheat yields were likewise al produced in 1926. However, this does not necessarily mean that the same fluctuations in the yields of either of these crops will be of the same degree, or occur

on the same plots in subsequent years. During extremely unfavourable years the fluctuations for each of these crops would undoubtedly be greater than those reported here. That the years 1925 and 1926 were not unusually unfavourable to these two crops must be admitted in view of the mean yield for oats being 88 bushels and that for wheat 32.2 bushels.

It will be observed (Figs. 2 and 3) that the fluctuations for the wheat crop are of smaller magnitude than are those for the oat crop, but it should be remembered that the wheat crop has an inherent tendency to show smaller fluctuations than are experienced in the oat crop.

The standard deviations for the oat crop (1925) and the wheat crop (1926) are respectively 10.43 and 6.43 per cent. of the mean; expressed as bushels per acre these deviations are, oats 9.18, and wheat 2.06. Considering the 124 plots the correlation coefficient for these two crops is $.08 \pm .089$. This lack of correlation is brought out by observing the curves in Fig. 3.

No attempt has been made to arrange the plots in various groupings and then determine correlations for each grouping since as stated above the data reported cover only two crops and two years. It will undoubtedly require the production of at least several more such blanket crops before this should be done. The crop to be grown on these plots in 1927 will again be Marquis wheat. Before these plots are devoted to systematic fertilizer treatments such a statistical study as above suggested will be made in order to determine the frequency and number of plots required for checks as well as for each respective treatment.

Some of the plots showing high yields for oats (1925) likewise gave high yields for wheat (1926), as for example 37 and 38, series A; 24, series B, and 31 to 36, series C (see Fig. 3); whereas other plots gav low yields for both oats and wheat, for ex ample plots 41 to 43, series A; 40, series I and 40 to 43, series C.

On the other hand some plots giving hig oat yields tended to give low wheat yield and vice versa; for example, plots 2, 9, 1C 28, and 40, series A. Others might be men tioned for series B and C.

The question naturally arises as to wha is the practical significance of the above re sults. The individual variations in yields fo the various plots have already been pointe out (Table 1, and Figs. 2 and 3) when al plots were producing the same variety. much greater variation in the yields can easil be visualized provided different varieties ha been used. However, in most variety test or fertilizer tests it is hardly likely that w would use only one plot even though it wer one-tenth acre in size. On the other hand is not uncommon to see the average result from duplicate plots for both fertilizer an variety tests, covering only one year, repor ed as being significant even when the plo are less than one-tenth acre in size. Let u suppose that instead of using only one variet of oats on all the 124 one-tenth acre plots w had used a number of varieties, and that eac variety had been grown in duplicate. It do not really matter where the selection of plo begins for the results will be similar thoug not identical. For convenience let us grou plots 1 and 11, 2 and 12, etc., up to 10 an 20. (Series A) and use them as duplicat indicating either variety tests or fertiliz responses for 10 such treatments. The ave ages of these ten duplicates are shown Table 2 when the same variety of oats w produced on all plots.

It will be seen that where only the avera of 2 one-tenth acre plots have been used t results in 60 per cent. of the cases (6 out 10) may be construed to be significant yields even though these differences we

Table II—Average Relative Yields of Oats from Duplicate Plots (Series A).

Plots	1,11	2,12	3,13	4,14	5,15	6,16	7,17	8,18	9,19	10,20
Relative Yields	101	101	102	92	93	84	92	102	92	89

Table III.—Average relative yields for three plots from Series A, and also of three plots similarly numbered from Series A, B, and C.

SERIES A										
Plots	1,11, 21	2,12, 22	3,13, 23	4,14, 24	5,15, 25	6,16, 26	7,17, 27	8,18, 28	9,19, 29	10,20, 30
Relative Yields	98	95	98	95	97	87	92	97	95	95
Similarly number plots from Series A, B, and C.										
Plots	A, B, C 20	21	22	23	24	25	26	27	28	29
Relative Yields	101	101	91	99	111	102	91	97	99	106

obtained when the same variety of oats had been grown on the 20 plots. Had 10 different varieties been grown in duplicates or had 10 different fertilizer tests been made in duplicate it might very naturally have been interpreted as showing significant differences in yields in favour of some of these varieties or fertilizer treatments.

From Table 2 it is quite clearly seen that ne averages of duplicate one-tenth acre plots re not sufficient to compensate for variations n plot yields to the extent that the results hus obtained could be used as indicating sig. ificant differences in the yielding power of ifferent varieties or different fertilizer treat ents. Clearly then more than two such plots hould be used as checks. Let us now con der the performance of 10 groups of 3 plots ich when selected from the same series (A) d again when similarly numbered plots om each of the three series are grouped. he averages of such groupings are recorded Table 3.

From Table 3 it may be seen that the aver- es of the groups of 3 one-tenth acre plots e significantly low in two out of the ten lumns both when the plots are selected om the same series and when similarly mbered plots are grouped for the three ries. Thus it may be seen that at least ore than three such plots should be used to tain reliable averages when only one sea- n's yields are being considered. In order bring the lowest relative yield in Table 3 to the average it would mean that the in- rent productive power of that variety of ts or that fertilizer treatment would of cessity have to be 13 per cent. better than average due to less favourable soil con- ions encountered on this group of plots.

Summary

From a review of the literature it would seem that universally there is a heterogeneous soil condition influencing the yields from the various plots within any experimental field and that seasonal influences also have a very great effect upon the relative yields from plots. All treatments apparently are not affected relatively the same each year. The greatest single seasonal factor influencing variations in yields in the supply of moisture and seasonal variations in yields are greater under dry-farming than under irrigation practices.

It is quite evident from data obtained at the University of Alberta from 124 one-tenth acre (untreated) plots, all producing Victory oats in 1925 and all Marquis wheat in 1926, that in so far as the variations in the oat yields from plot to plot are concerned, and similarly for the wheat yields, these variations may rightly be attributed to the heterogeneity in the soil, since the oat yields were all produced under the same climatic conditions (1925) and the wheat yields were likewise all produced in 1926. However, this does not necessarily mean that the same fluctuations in the yields of either of these crops will be of the same degree or occur on the same plots in subsequent years. During extremely unfavourable years the fluctuations for each of these crops would undoubtedly be greater than those reported here. That the years 1925 and 1926 were not unusually unfavourable to these two crops must be admitted in view of the mean yield for oats being 88 bushels and that for wheat 32.2 bushels.

The land had never been cropped previous to 1923. In 1923 and 1924 blanket crops of

oats were grown on all the plots, but owing to the scarcity of help it was impossible to harvest these crops as individual plots. The crops in 1925 and 1926 were thus respectively the third and fourth crops that had been produced after the land had been cleared and broken from its virgin condition.

The extreme variation in the yield of oats for 1925 was 48.6 bushels (plots 36 and 43 series A) or a variation from the mean of 55 per cent. The extreme variation in the yield of wheat for 1926 was 10.4 bushels (plots 37 and 33 series A) or a variation from the mean of 32 per cent.

The greatest variation for plots lying adjacent was 22.9 bushels for oats (plots 39 and 40 series A) and 4.9 bushels for wheat (plots 36 and 37 series A). These variations expressed in terms of percentages of the means are respectively 26 and 15 for oats and wheat. The fluctuations for the wheat crop are of smaller magnitude than are those for the oat crop, but it should be remembered that the wheat crop has an inherent tendency to show smaller fluctuations than are experienced in the oat crop.

The data presented here are intended only as a progress report. Final conclusions must await the returns of at least several more years. However, it is hoped that these data will impress the value of the necessity for systematic performance tests for plots which are to be used as rotation, fertilizer or variety yield experiments and act as a restraint from temptations to draw sweeping conclusions regarding fertilizer or variety yields from the results of a limited number of expecially small plots and a limited number of years.

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The Effect of Feeding Thyroid to Fowls.*

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One of the problems with which biologists ıre confronted is that of discovering the func- ions and interactions of the various endo- rine glands. It is the purpose of this paper o report new contributions to our knowledge f the thyroid gland which have been made ı recent years by investigators who have sed the domestic fowl in their experiments.

It is difficult to arrive at a complete know- dge of the action of an organ so long as it ınctions in a normal manner. The obvious ıethod of attack is to remove the thyroid and and see what happens. Thyroidectomy, owever, is a difficulty operation in the fowl ıd its successful accomplishment has not t been reported. The other alternative is induce hyperthyroidism by feeding the and or injecting extracts of it.

Prior to the work with fowls it had been tablished that the general effect of feeding yroid to animals is an increased oxidation th a resultant rapid catabolism of proteins d fat and consequent loss in weight. Two ıer specific effects not due to the higher tabolism had also been noted, viz—an in- ased rate of metamorphosis in axolotls and lpoles and a resistance to acetonitrile pois- ing in white mice.

In 1922, Torrey and Horning (1) reported t desiccated thyroid fed to growing Rhode and Red chicks resulted in the assumption female plumage by cockerels, but not by ons.

n all normal domestic fowl, except Se- ght Bantams and some strains of Campines, neck, wing-bow and saddle feathers of the e differ from those in the corresponding ions of the female by having a marginal e around the distal end in which the barbs barbules and hooks. Such feathers ap- r pointed and silky in contrast to the ıded dull feathers of the female. This erence constitutes a secondary sex charac- i.e.—a condition generally considered due he endocrine secretion of the gonad and endent for its expression either as male emale plumage on whether it is influenced ı testicular or an ovarian hormone.

Torrey and Horning had thus by feeding thyroid produced in male fowl a condition normally caused by the hormone of the ovary. An experiment by Crew and Huxley (2) with fifteen-weeks old cockerels did not confirm these results, but Cole and Reid (3), feeding desiccated thyroid to Brown Leghorn cock- erels were able to do so. The birds used in this case were mature and therefore it was necessary, after thyroid feeding commenced, to pluck a patch of feathers from the neck, wing-bow and saddle regions, so that new feathers might grow in which were exposed to the influence of the thyroid. It was noticed that the new feathers not only tended toward female structure, but were of much darker color. Cockerels fed free iodine or potassium iodide gave neither of these re- sults, indicating that the phenomena were due to the active principle of the thyroid gland and not simply to the additional iodine in the ration.

In this experiment it was also noted that the new feathers grew more rapidly on the thyroid fed birds than on the controls. A further test of this apparent stimulus for feather growth was made by the writer at the University of Wisconsin in 1924. It was found that a dose equivalent to 59 milligrams daily of desiccated thyroid (.2% iodine) per pound of live weight caused a much more rapid moulting and growth of new feathers than was observed in controls. During six weeks of feeding, this dosage was found to cause no loss in weight. Records of egg pro- duction for a period of four months from the start of the experiment showed no signifi- cant difference in this respect between twenty thyroid-fed hens and twenty controls.

In 1924 Giacomini (4) reported that com- paratively large doses of fresh ox thyroid fed to fowls caused loss in weight, atrophy of the oil gland, rapid moult and depigmenta- tion of new feathers. These results were obtained in cocks, capons and hens and in both black and gold breeds. Giacomini's

*An Address delivered before the Scientific Club of Winnipeg, on Jan. 4th, 1927.

birds were started on small pieces of thyroid and the dose increased to pieces weighing about five grams fed on alternate days.

Giacomini apparently observed no hen feathering in thyroid-fed males and the depigmentation of feathers described by him was in direct contrast to the darker feathers noted by Cole and Reid. It seemed possible that there might be some difference in physiological properties between the raw thyroid and the desiccated powder. To determine if this were so, further experiments were carried out at the University of Wisconsin in 1925. Cocks and hens were fed desiccated thyroid (.2% iodine) at the rate of 84 milligrams per pound of live weight while other cocks and hens of the same varieties were given daily doses of fresh pig thyroid five times as great. Since a gram of the desiccated thyroid used was equivalent to five grams of the fresh gland the doses of thyroid iodine were approximately equal. Ten males and eight females representing nine breeds were used. Feathers were plucked from the neck, wing-bow and saddle regions of all birds one week after feeding commenced.

Administration of thyroid was continued for thirty-seven days during which time it became evident that female feathers could be induced in males by feeding either desiccated or raw thyroid. However, feathers growing in after six weeks of feeding showed no tendency toward henny structure, indicating that the effect was only temporary at this dosage.

It is of interest to note that the plumage structure in Sebright males (normally hen feathered) was unaffected by thyroid feeding.

No depigmentation was noticed except for very small white spots in the marginal lacing of new feathers in these Sebrights. There was no significant loss of weight in any of the birds in this experiment.

Darker feathers were obtained in the neck region of Silver Wyandotte males. (Fig. 1) Cocks and hens of this breed have feathers different in color pattern as well as in structure. In these tests, feathers typically female both in structure and pattern were produced in the males. On the wing-bow where the male feathers had been slate at the base with the remainder white, the new feathers were white with a black margin as in hens. (Fig. 2) Similarly on the saddle the new feathers were white with a black lacing where those plucked had been black with a white edging. In dimorphically colored breeds the plumage pattern is associated with feather structure as a secondary sex character. In this case, the evidence seems conclusive that the sex character has been altered by thyroid influence from a male to a female expression.

In 1925 there appeared results of experiments begun in 1919 and continued for five years by B. and M. Zavadovsky (5) (6) in Russia. These workers fed comparatively enormous doses of fresh and desiccated thyroid and noted as a result rapid moult

FIG. 1*—Neck feathers from Silver Laced Wyandott
1—from normal female.
2—from normal male.
3 and 4—from thyroid-fed male.

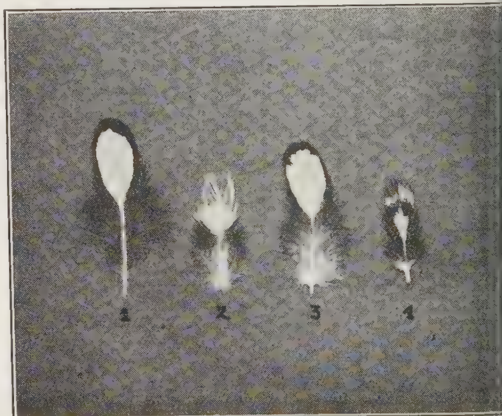

FIG. 2*—Wing-bow feathers from Silver Laced W dottes.
1—from normal female.
2—from normal male.
3—from the thyroid-fed male.
4—from the thyroid-fed male—intermediat pattern and structure between 1 and
*Photographs by Dr. A. Savage.

ing with accompanying depigmentation of new feathers. Their doses went as high as one-and-a-half beef or horse glands per day. Symptoms of hyperthyroidism noted were hunger and thirst, increased excitability, followed by loss of appetite, incoordination, stupidity and in some cases convulsions and death. It was also found that these symptoms were avoided but the rapid moult and depigmentation were obtained when single doses ranging up to 50 grams of desiccated thyroid (iodine content unstated) per bird were given. The minimum effective dose was one to two grams of desiccated thyroid per kilogram of live weight.

A most interesting property of thyroid was discovered by Crew (7) who found that administering desiccated thyroid to aged cocks and hens in advanced senility resulted in a distinct rejuvenation. Egg production of the hens was increased during the six months of thyroid feeding and cocks were restored to sexual activity. All of the birds moulted and new feathers were much darker in color in the majority of birds. This difference was most marked in those fowls whose plumage had become paler with the onset of senility. Male plumage was replaced by henny feathers in cocks but no depigmentation was noted. The dose used in this work was .2 mgm. of thyroid iodine per bird for the first two weeks, .4 mgm. in the second two weeks and thereafter .8 mgm. The latter dose is equal to .4 grams of Armour's desiccated thyroid (the material used) daily per bird.

The power of thyroid substance to rejuvenate old birds is not only of scientific interest, but also of considerable practical value. The value of a fowl as a breeder depends on the performance of its progeny and this cannot be completely known till the fowl is three years old. Normally the onset of senility can be expected at from five to seven years. If a male of tested value can be utilized for one or two extra breeding seasons by dosing it with thyroid, the labor and time required for progeny-testing will be rendered much more profitable.

It is interesting to note that Crew had previously failed in an attempt to bring about rejuvenation of senile male fowls by unilateral ligation of the vas deferens, the so-called "Steinach operation" which has been effectually used for this purpose in mammals.

In all this work results obtained by different investigators had not been identical. It seemed possible that this was because different doses, in some cases not exactly stated, had been used. To determine the effects of different doses an experiment was conducted at the Manitoba Agricultural College last winter. Ten mature Black Minorca pullets were fed desiccated thyroid (Parke, Davis & Co. .3% iodine) at levels ranging from 4 mgm. thyroid iodine per 1000 grams to 4 mgm. per 10,000 grams of body weight daily. Six males were put on daily doses of 4 mgm. thyroid iodine to 1000, 2000, 3000, 5000, 7000 and 10,000 grams of body weight. The birds were weighed every three days and the amounts fed to each fowl were revised so that the rates of dosage were kept constant. Feeding was continued for 31 days.

The two heaviest doses, viz., 4 mgm. thyroid iodine to 1000 and to 2000 grams of body weight proved lethal to both males and females. The general symptoms were an intense thirst, rapid loss in weight, lack of coordination and dullness. On autopsy the ureters were found to be congested with urates as would be expected from the greatly increased protein metabolism. The male on the heaviest dose had greatly hypertrophied testes.

All surviving males, except the control, grew hen feathers where patches had been plucked after the start of the experiment. Depigmentation in new feathers of surviving fowls was most marked in those on the heavier doses and not evident at all in those receiving only .4 mgm. iodine per 1000 grams of body weight. In the fowls which moulted, new primary and secondary wing feathers exhibited depigmentation varying in degree from feathers almost pure white to some with only gray tips.

To sum up the experimental work with fowls, three new properties of the thyroid when fed in greater than physiological doses have been established. These are:—

1. An effect on the pigment forming mechanism.

It seems probable that the increased oxidation induced by medium doses of thyroid causes more pigment to be oxidized to black than is normal. So far as the writer is aware it has not yet been shown that this effect is produced in buff or white fowl which do not carry in their genetic constitution a

factor for black pigment. In our own experiments the color of Buff Leghorns was entirely unaffected by thyroid feeding. The depigmentation obtained when very large doses of thyroid are fed seems to indicate that at a certain stage of oxidation the pigment-forming mechanism is entirely arrested.

2. An interaction with the gonad which results in the assumption of female plumage by male fowl and a rejuvenation of senile fowl of both sexes.

Crew has suggested that the difference between the plumage of male and female fowls is due, not to specific testicular or ovarian hormones as has been generally accepted, but to different levels in metabolism. He suggests that normally the ovary exerts a greater demand on the thyroid of the fowl and causes secretion of sufficient thyroid substance to raise the metabolic rate and produce hen feathering. The testis makes a lesser demand on the thyroid and consequently a lower metabolic rate is induced and the feathers of the male are altered very little from those of a capon. Feeding thyroid to males increases the metabolic processes to the same level as in the female and, as a result, female feathers are produced.

This may be possible but it is not in accordance with the theory of Riddle, who, after many years' work with pigeons, is convinced that the higher metabolism is associated with the male sex rather than with femaleness. Riddle, however, does believe that secondary sex characters are the results of different levels of metabolism rather than of specific hormones.

It would seem that further experimental work is necessary before any conclusion can be drawn regarding the interaction of the hormones of the thyroid and the glands.

3. A stimulus for moulting followed by rapid growth of feathers. This is evidently due to a more rapid rate of cell division induced by the increased oxidation resulting from feeding thyroid.

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CONCERNING THE C.S.T.A.

Owing to the large size of this issue it has been impossible to devote the usual space to the activities of the C.S.T.A. These will be featured in the next number.

At the time of writing the membership of the Society has reached a total of 986 and the List of Members, with their titles and addresses, has been turned over to the printers. It is hoped that this booklet can be mailed to each member before the end of March, and that it may yet be possible to increase the membership to 1,000 before the final printing is completed.

The dates for the Seventh Annual Convention have been practically decided—June 15th to 18th inclusive, at Vancouver, B.C.

All outstanding membership fees for the current year should be paid immediately, either to the local secretary or to the General Secretary.

The Correlation Between Climate and the Yield of Farm Crops in Prince Edward Island.

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The data on which this article is based are taken from the records obtained at the Experimental Station, Charlottetown, P.E. Island, during the years 1912 to 1925 inclusive. The Experimental Station (Figure 1) adjoins the city of Charlottetown and is located geographically 63° 7′ west longitude, and 46° 15′ north latitude. It is near the center of the land area of the province and conditions at this point should fairly represent average conditions of climate and crop yields throughout the Island.

The climate of P.E. Island is greatly modified by its location in the southern portion of the Gulf of St. Lawrence and the extremes of heat and cold that are unfavorable to crops do not occur. According to Hopkins (5) Prince Edward Island is located climatically on Isophane 54 and between phenological meridians 60 and 65. This indicates a very favorable climate for spring cereals, forage crops and potatoes. Its cool maritime climate is particularly favorable for the growing of roots and tubers. These climatic conditions are important factors in crop production.

The meterological records were carefully studied in relation to their effect on all the main farm crops. The means, totals and averages for temperature, precipitation and sunshine are given for the years 1912 to 1925 inclusive in tables No. I, II, III, and IV. The frost free period described by the U.S. Weather Bureau (9) indicates the length of the

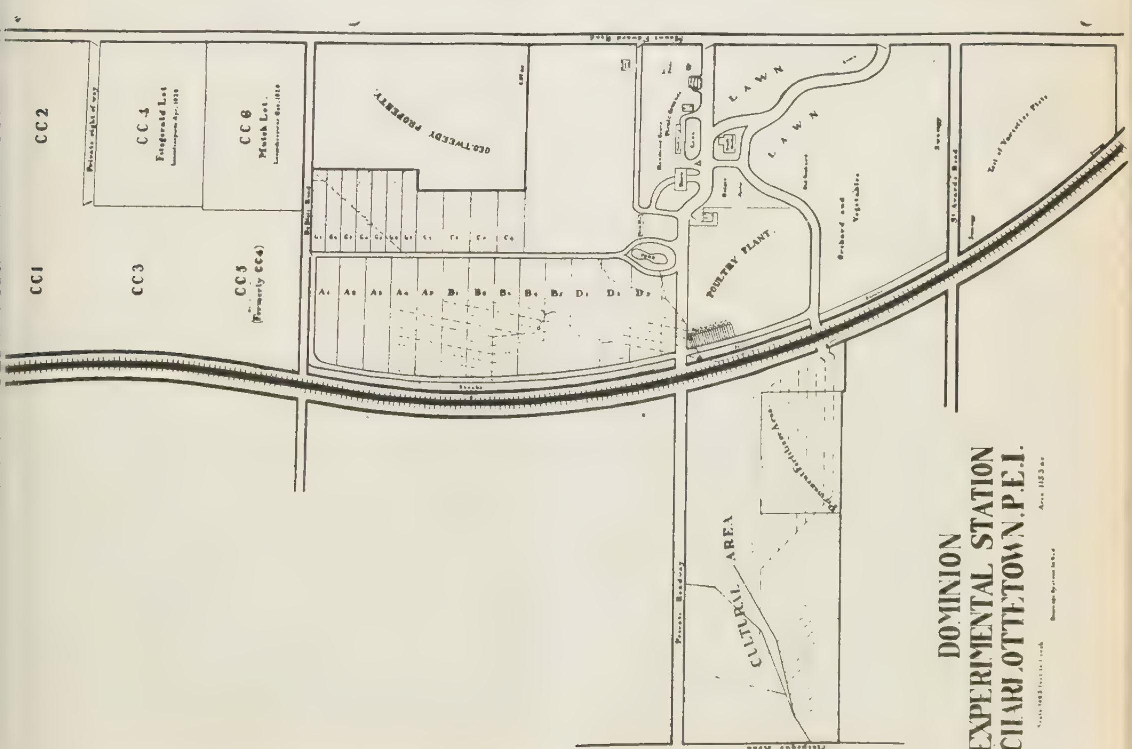

Fig. 1. Plan of the Charlottetown Experimental Station showing the location of the four rotations: "A", "B", "C" and "G".

Fig. 2. Farm crops, Rotation "B", Charlottetown, P.E. Island.

Fig. 3. Farm Crops on Rotations, Charlottetown, P.E. Island.

growing season for the more tender plants. It is the controlling factor in the production of corn and to some extent of mangels at Charlottetown. The interval between killing frosts is very much greater than the frost free period in Prince Edward Island, and is a more important period in connection with most farm crops. This interval is sufficiently long for spring cereals and for all the principal forage crops, grown elsewhere in Canada to mature. The crops on the farm rotations at Charlottetown (Fig. 2 and 3) have not been injured by frost since the Station was established.

The average frost-free period for the last fourteen years was 140.9 days, and ranged from 131 in 1912 to 175 days in 1923. Table I gives particulars regarding temperature relationships and certain classes of farm crops:

The mean temperatures by periods for the fourteen years were as follows: For the five winter months Nov. 1st—March 31st 24°F; The four growing months for hay, April to July, 51.8° F.; For the six growing months, April to September, for cereals and potatoes 54.8° F.; For the seven growing months, for roots, April to October, 53.9° F. The average annual mean temperature for the four-

TABLE I.

Table of Mean Temperatures for March and the Growing Seasons with Average Yields of all Crops per acre summed in Scandinavian Feed Units per acre and the Frost Free periods 1912—1925 for Prince Edward Island.

Year	Mean Temperatures				Scandinavian Feed Units	Frost Free Period		
	Growing Season Clover and Grasses April 1st—July 31st	Growing Season Cereals and Potatoes April 1st—Sept. 30th	Growing Season Turnips and Mangels April 1st—Oct. 31st	March Mean Temperature	Average S.F. Units from all crops on an Acre Basis.	Last Spring Frost	First Autumn Frost	Frost Free Period
					Units	Date May	Date Oct.	Days
1912	52.2	54.1	53.2	25.9	2426	23rd	2nd	131
1913	52.1	54.8	54.9	30.8	2198	17th	31st	166
1914	40.7	53.7	52.8	28.9	2459	17th	7th	142
1915	50.1	53.6	52.7	25.8	2759	18th	2nd	136
1916	51.9	55.4	54.5	19.5	2757	22nd	11th	141
1917	51.1	54.7	53.9	26.6	2314	23rd	8th	137
1918	51.9	54.8	53.7	19.9	2523	12th	2nd	142
1919	52.3	55.0	53.4	27.6	2722	16th	8th	144
1920	52.1	55.8	55.1	29.5	2562	15th	21st	158
1921	54.1	56.4	55.3	31.7	2308	11th	17th	158
1922	52.8	55.7	54.5	27.6	2176	16th	14th	150
1923	50.2	55.2	52.9	19.3	2503	4th	28th	176
1924	52.3	55.5	54.3	29.2	2702	22nd	21st	151
1925	52.8	55.4	53.5	31.9	2469	24th	12th	140
Avg	51.8	54.8	53.9	26.7	2472			140.9

TABLE II.

Mean Temperatures (Degrees Fahrenheit). Charlottetown, P.E. Island for the Period 1912-1925.

	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	14 year mean
Month	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
January	12.5	24.2	10.3	21.6	18.9	15.0	15.4	21.2	8.1	19.1	16.5	14.5	18.4	10.0	16.1
February	17.4	13.5	9.8	22.6	17.1	14.8	13.6	22.8	20.5	15.4	15.0	6.7	13.5	25.1	16.3
March	25.9	30.8	28.9	25.8	19.5	26.6	19.9	27.6	29.5	31.7	27.6	19.3	29.2	31.9	26.7
April	35.7	40.1	32.6	37.5	36.8	37.2	35.5	38.0	35.7	40.2	36.6	34.4	34.4	37.2	36.6
May	50.5	45.1	48.5	44.7	47.4	41.2	50.4	47.9	47.8	49.7	48.4	46.4	49.3	48.6	47.6
June	57.8	59.1	54.7	54.8	59.2	60.3	56.8	59.2	57.8	58.0	62.3	56.8	58.6	60.1	58.2
July	64.9	64.2	63.2	63.6	64.4	65.6	65.0	64.1	67.3	68.6	63.9	63.1	67.1	65.3	65.0
August	61.7	64.4	64.0	63.6	65.5	68.2	62.2	63.9	68.3	62.7	66.2	61.9	65.8	66.1	64.6
September	54.0	56.1	59.0	57.2	59.2	56.0	58.7	56.9	57.8	59.4	57.0	56.9	57.7	55.1	57.2
October	47.7	55.1	47.8	47.7	48.8	48.7	47.6	44.0	50.9	48.6	47.1	50.5	47.5	42.1	48.1
November	37.0	38.8	35.3	38.5	32.9	33.2	35.9	26.7	32.9	33.3	32.9	40.6	39.2	35.9	35.2
December	26.6	27.6	22.7	29.7	28.3	19.8	25.0	19.1	26.1	24.0	19.2	32.2	21.2	22.1	24.5
Average Annual Temperature	41.0	43.2	39.7	42.3	41.5	40.6	40.5	41.0	41.9	42.6	41.1	40.3	41.8	41.6	41.4

TABLE III.

s

Precipitation at Charlottetown, P.E. Island, 1912—1925, in Inches.

	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	Mean for Years 14	49
Month																
January	3.45	3.58	3.93	5.32	3.61	4.13	3.91	3.10	1.45	3.78	4.43	4.57	3.00	3.80	3.72	3.44
February	5.58	2.52	3.63	2.34	2.80	3.95	3.73	2.48	4.81	2.55	2.75	.55	2.65	2.95	3.09	2.57
March	3.63	4.61	3.42	2.35	6.60	2.59	4.78	3.25	4.75	3.80	1.35	4.93	3.99	4.21	3.87	3.14
April	3.16	3.86	3.78	2.50	3.28	3.46	.89	4.09	4.66	3.27	2.21	2.30	2.17	1.44	2.93	2.93
May	2.64	3.00	2.05	3.97	2.08	3.52	1.84	2.91	.99	1.68	2.17	2.91	1.35	2.82	2.42	2.59
June	2.49	1.27	5.32	3.13	2.74	2.54	3.25	2.22	2.49	1.14	4.72	3.63	3.47	4.80	3.09	2.63
July	6.83	4.01	2.84	1.95	4.14	1.92	4.53	3.29	2.38	.80	3.73	2.09	1.00	1.87	2.95	2.88
August	2.68	2.89	2.43	2.22	1.79	4.93	1.37	4.13	3.56	3.61	3.95	2.23	5.38	2.00	3.08	3.35
September	2.90	3.98	5.02	3.98	2.02	1.71	5.60	4.78	3.76	4.15	2.01	4.61	2.88	5.92	3.81	3.46
October	3.72	7.71	3.57	3.83	4.22	7.02	5.51	3.71	.60	2.32	2.48	5.30	2.29	6.49	4.20	4.99
November	4.24	2.09	2.65	4.51	3.74	4.06	3.52	3.17	2.20	4.18	2.21	3.41	3.31	1.89	3.23	4.00
December	6.45	3.76	2.02	7.35	4.55	5.65	5.26	2.60	3.72	5.48	4.35	4.36	3.33	1.98	4.35	3.74
Average Annual Precipitation	47.8	43.3	40.7	43.5	41.6	45.5	44.2	39.7	35.4	36.8	36.4	40.9	34.8	38.5	40.6	39.2

teen years was 41.4° F. The month of April though a part of the growing season for the grass and clover crops only, is included with the periods for the other crops as it has quite an influence on the drying out of the land for the several crops.

Table II gives mean temperatures at Charlottetown during the fourteen-year period.

Table III gives the monthly precipitation at Charlottetown, Prince Edward Island, for he years 1912-1925 inclusive.

The rainfall during the growing months ogether with the winter's accumulated preci-itation appears to have been quite adequate or all the main farm crops. No definite orrelation was established between the rain-all and the yield of any of the principal farm rops. The average annual precipitation for he fourteen years was 40.6 inches and for he forty-nine year period it was 39.2 inches. he showers of rain were well distributed hroughout the growing season and it has been oted that many of these occurred at night.

Table IV gives the hours of bright sunshine er month and per year during the period 912—1925 inclusive.

There seems to have been sufficient bright inshine for the growing crops, and no gnificant correlation was observed between e hours of sunshine and the yield of the rincipal farm crops.

The only correlation of weather records id farm crops that seemed to be significant as between the mean March temperatures id the average yield of farm crops on the tations at Charlottetown. A low mean tem-rature during March indicated a late spring, id late springs appear to be quite favorable r all the main farm crops in the province, cept corn.

The Scandinavian Feed Unit was used as basis of crop yields.

In order that the total yields from the four ferent rotations, (Fig. 4) might be sum-d for yearly comparison, it was necessary secure some common basis for all the crops; d in as much as dairying was a central ture of the mixed farming followed at Station and in the community, it was ught that the value of these crops as fed dairy cows would form the best basis for nparison. The test of the different crops l their value when fed to dairy cows is orded in the Statistike Meddelelser (6).

TABLE IV.

Hours Bright Sunshine, Charlottetown., P.E. Island, 1912—1925.

	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	14 years Mean
January	128.3	82.6	79.6	72.4	91.6	114.8	111.9	70.9	87.9	81.1	117.0	80.6	101.5	119.7	95.7
February	118.1	117.6	138.3	94.6	117.4	128.4	104.3	99.1	73.2	113.8	113.6	165.2	156.8	86.1	116.2
March	149.6	131.0	128.5	86.4	129.8	178.2	139.9	129.2	130.4	128.4	170.7	137.3	91.6	121.3	132.3
April	163.1	148.5	194.9	140.9	164.2	96.8	183.0	100.2	150.7	151.3	129.8	129.5	125.1	156.3	145.3
May	233.3	195.6	190.4	160.1	209.4	121.3	234.2	215.2	312.4	255.4	218.1	181.7	233.9	214.6	212.5
June	250.1	255.5	247.7	193.2	202.7	179.9	245.7	230.5	247.5	231.0	190.6	217.7	236.5	213.7	224.4
July	195.8	223.1	277.9	238.9	233.4	186.2	181.9	208.9	272.9	253.0	176.1	219.9	304.0	197.5	226.4
August	181.9	251.2	247.9	203.3	251.7	227.9	254.1	209.3	226.2	261.9	213.7	255.4	215.2	234.9	231.0
September	167.9	182.3	191.0	169.9	188.6	246.5	153.1	151.2	150.7	229.0	212.4	189.6	185.6	144.6	183.0
October	134.2	66.3	135.9	146.0	120.0	136.9	108.1	113.8	160.4	135.7	141.6	157.3	151.9	131.5	131.4
November	51.7	101.6	96.5	58.6	88.2	73.5	62.6	52.0	83.1	45.6	38.3	73.2	107.8	101.8	73.9
December	68.7	62.5	99.9	48.1	32.7	46.2	49.7	86.1	45.8	37.0	67.7	45.8	71.7	77.8	60.0
Avg. Annual Hours Sunshine	1843	1818	2028	1612	1830	1737	1828	1666	1941	1923	1790	1853	1982	1800	1832

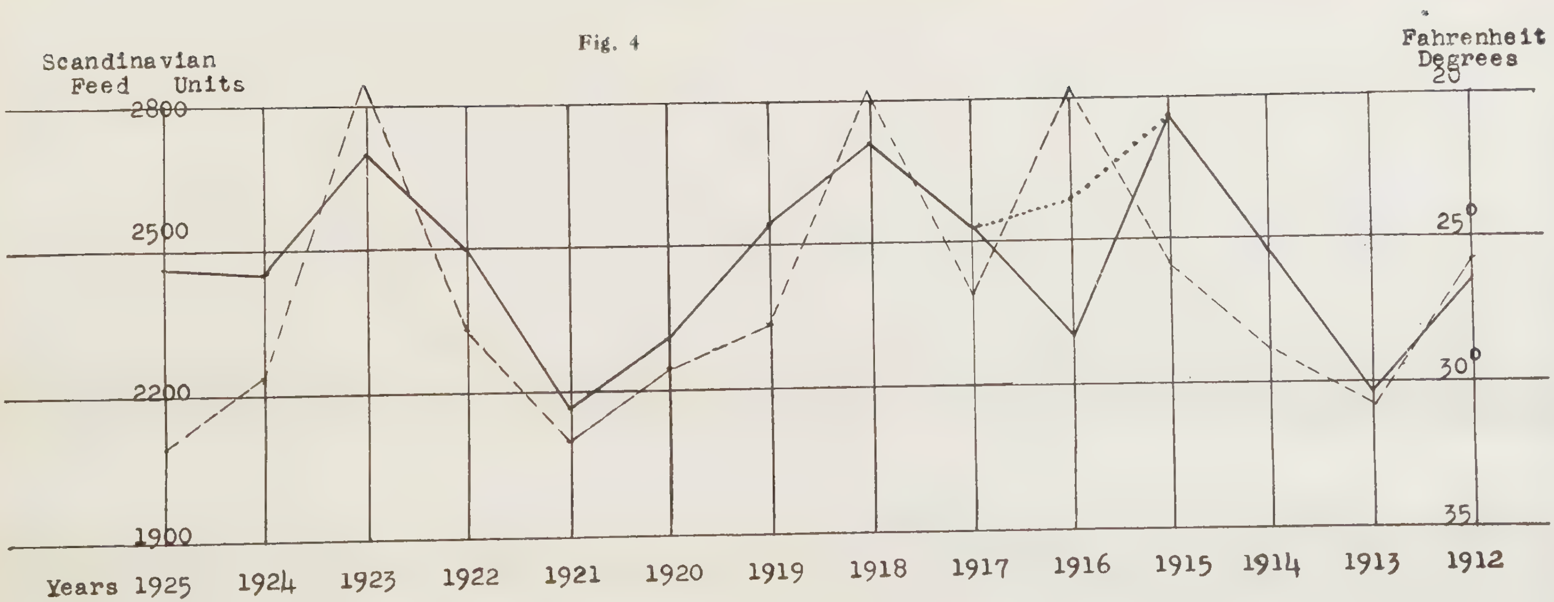

Fig. 4 Showing Correlation Between March Mean Temperatures and the Average Annual Yield of Farm Crops at Charlottetown, P.E. Island.

------ The broken line indicates the March Mean Temperatures.

——— The solid line indicates the Yield per acre of Farm Crops in Scandinavian Feed Units.

...... The dotted line shows the adjustment used in 1916.

The Correlation was $-.53 \pm .11$ Corrected $-.74 \pm .06$

The measure devised was called the "Scandinavian Feed Unit", and it is described by Faber (4). The table of feed units for dairy cattle by Woll (7) as adapted to Canadian farm crops by Boving (2) was used.

The values in feed units for barley straw and wheat straw were worked out from unpublished data supplied by Boving (2). These were: 5 pounds of barley straw or 8 pounds of wheat straw equalled one feed unit.

The statistical methods used were those described by Davenport (3). The probable errors were worked out according to Bessel's formulae as described by Wood and Straton (8).

Figure 4 is a graphical representation of the correlation that was observed when the yields per acre of all crops on the four rotations were summed on a common basis, (see Table I) the Scandinavian Feed Unit (4) and plotted with the mean March temperatures. When this graph was drawn it was observed that there was a marked deviation from the general trend of the correlation in 1916. Crop conditions were favorable that year throughout the province and an adjustment is shown for 1916. This was obtained by securing the data on the yield of all the main farm crops in the Province for the period 1912-1925 as given in the Dominion Bureau of Statistics, Monthly Bulletin (1) each year. These were converted into Scandinavian Feed Units, summed and the relative yield of farm crops for the province for 1916 was found to be 105 per cent. The adjustment is shown by a dotted line on the graph.

The correlation was $-.53 \pm .11$. When the adjustment as described was made it was $-.74 \pm .06$.

SUMMARY

This investigation has shown that an average mean temperature for the month of March in Prince Edward Island has usually been followed by a normal spring, and farm crop yields that were very close to the average of many years. A high March temperature and an early spring has been followed by greatly reduced yields, amounting in some cases to less than 90% of all crop averages. The low mean temperature for March on the other hand has been followed by a late spring and greatly increased yields, amounting to as much as 5% above the normal of all crop averages. This correlation will be quite valuable in selecting crops to suit the season; the corn crop being practically assured following a high mean temperature in March. Other crops should be used to replace corn in P.E. Island, when March is cold.

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The Dissemination of Weed Seeds by Irrigation Water in Alberta.

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Under the direction of the Supervising Analyst in Calgary, Mr. Leggatt, an investigation was commenced on the above subject in 1924, and, from the results obtained, it was seen that much interesting and important data might be obtained by extending the investigation over the years 1925 and 1926 in different irrigation districts.

It may be explained here that irrigation is practised to a great extent in Southern Alberta where the normal precipitation is very low during the growing period, and the water is conveyed in some cases a considerable distance for this purpose. The land is gently rolling and strong winds are frequent with the result that weed seeds may be blown into the canals and ditches and then deposited on the land when irrigation is in use. It will also be seen that weeds which had not been present previously in a district can be introduced from another district.

The apparatus used was a cylindrical trap, 10 inches long and 3¼ inches in diameter made of 50 mesh wire. This is similar to one used by Egginton of Colorado who made a similar investigation in that state. (Proc. A.O.S.A.N.A. 1921).

The first district visited in 1924 was the C.P.R. Eastern. The centre of this district is Brooks, situated on the main C.P.R. line between Medicine Hat and Calgary. The point at which the investigation was made was on a distributary from the East Branch of B Canal—about 2 miles west of Brooks. In this district there are 35 miles of ditch and the irrigation area is 400,000 acres. The dam controlling the irrigation water is near Bassano and the volume of water at the time of investigation was 37 cubic feet per second. The banks of the ditches visited were found to be infested with Canada Thistle, *Cirsium arvense* (L) Scop. and Curled Dock, *Rumex crispus* (L). The danger of these two weeds being carried by the water can be readily understood, especially as they grow under such favourable conditions. Where the adjacent land is higher than the ditch, and therefore non-irrigable, vast areas of Russian Thistle, *Salsola Kali* (L) are found and in the course of time the seed-bearing plants are blown by the wind into the ditches and settle in the mud at the bottom. The ditches are cleaned out periodically and masses of weeds drawn to the banks.

Adjacent to the ditches the following weeds were observed:

Malvastrum coccineum (Pursh) Gray.
Gaura coccinea (Pursh)
Achillea millefolium L.
Cyperaceae.
Epilobium angustifolium L.
Artemisia biennis Willd.
Agastache Foeniculum (Pursh) Ktze.
Antennaria canadensis Greene.
Oxytropis Lamberti Pursh.
Sisymbrium altissimum L.
Lepachys columnaris (Sims) T.&G.
Potentilla sp.
Ranunculus Cymbalaria Pursh.
Zygadenus sp.
Astragalus sp.
Vicia sp.
Erysimum asperum D.C.
Draba nemorosa L.
Phlox subulata L.
Sherardia arvensis L.

In considering the analyses of weed seed catches in the following and subsequent tables, it should be constantly borne in mind that the figures given are only estimates and not in any sense absolute. A very large factor has necessarily been introduced in bringing each catch to the same basis for comparison, namely the number of weed seeds passing a given point per day. In this way also the lack of uniformity between different catches under similar conditions has been unduly exaggerated. However, this lack of uniformity is bound to occur for two main reasons. A gust of wind may shower an undue proportion of weed seeds on the water at one point. If the section of water thus contaminated

passes the trap, the catch will be very high. On the other hand a mass of flotsam may obstruct the canal for a while, thus more or less filtering the water passing it, till it breaks loose when a large number of weed seeds are liberated and contaminate a small body of water. In these ways a great variation in the weed seed content may be brought about. When any such conditions were actually observed to occur while a catch was being made, the catch was of course discarded.

Analysis of Weed Seed Catch

Table 1.

1st Catch. June 25, 1924. 8.15 to 9.15 a.m. Trap submerged ¾″. Width of water 12′. Location —At entrance to lateral. Velocity of water one mile per hour.

Number of weed seeds passing per 24 hours, on the surface and to a depth of ¾″:

Rumex crispus L.	7540
Polygonum sp.	1885
Chenopodium album L.	58435
Potentilla sp.	3770
Amaranthus retroflexus L.	22620
Polygonum Persicaria L.	3770
	98020

Analysis of Weed Seed Catch

Table 2.

2nd Catch. June 25, 1924. 11.00-12.00 a.m. Trap submerged 1″. Location near No. 1 catch.

Number of weed seeds passing per 24 hours, on the surface and to a depth of 1″:

Hordeum jubatum L.	998
Rumex crispus L.	1996
Chenopodium album L.	11976
Polygonum sp.	2994
	17964

Analysis of Weed Seed Catch

Table 3.

3rd Catch. June 25, 1924. 2.30—3.30 p.m. Trap submerged ⅓ of diameter. Same location as No. 2.

Number of weed seeds passing per 24 hours, on the surface and to a depth of 1″:

Rumex crispus L.	6692
Chenopodium album L.	8365
Amaranthus retroflexus L.	10038
	25095

Analysis of Weed Seed Catch

Table 4

4th Catch. June 25, 1924. 3.30—4.30 p.m. Trap submerged ½ of diameter. Same location as No. 2.

Number of weed seeds passing per 24 hours, on the surface and to a depth of 1.57″:

Chenopodium album L.	12177
Amaranthus retroflexus L.	1353
	13530

This investigation was continued at intervals during the summer of 1925. Several of the irrigation districts in Southern Alberta were visited for this purpose and on the dates shown in the tables with a view to ascertaining the weed seed content of water derived from a different source than that of the Brooks district where an investigation was carried out during the previous year.

The largest irrigation district south of Calgary is the Lethbridge Northern, covering an area of 105,000 acres, with its headquarters at Lethbridge, and visits were made to different points of the system with the results given below. Other irrigation districts visited were Taber, Glenwoodville and Coaldale, the first two mentioned being independent schemes operated by farmers in the locality and the third by the C.P.R.

It may be mentioned that 1924 and 1925 are considered years in which weeds were more prevalent in Alberta than usual owing to higher precipitation during the summer months than the average.

A severe snowstorm at the end of September and beginning of October stopped further work on the investigation. This is naturally the period at which large quantities of weeds would be found running in the water. An indication of the kinds expected will be found however in the lists given of weeds observed growing at the various points.

The first point visited was Taber on May 19. This is an independent scheme operated by the farmers in the district and comprises about 17,000 acres of irrigable land most of which is under actual irrigation. The water is obtained from Chin Lake which is a reservoir of the C.P.R. Lethbridge System. In order to overcome the weed seed problem $1500 has already been spent in seeding down the banks of the ditches on this project with a mixture of Brome, Western Rye and Timothy. Unfortunately at this date no irrigation was

in operation. However, the following weeds were observed in the immediate vicinity of the ditch:

Epilobium angustifolium L.
Potentilla monspeliensis L.
Antennaria sp.
Achillea millefolium L.
Hedysarum boreale Nutt.
Vicia americana Muhl.
Phlox subulata L.
Rosa arkansana S. Watts
Hordeum jubatum L.
Salsola Kali L.
Cirsium arvense (L.) Scop.
Cirsium lanceolatum (L) Hill
Erigeron canadensis L.
Polygonum Convolvulus L.
Cyperus sp.
Sisymbrium altissimum L.

Monarch was visited on June 9th, a point on the Lethbridge Northern System. This project covers 105,000 acres lying north and northeast of Lethbridge. The intake is in the Peigan District and the water is diverted from the Oldman River, there also being a storage reservoir at Keho Lake, which is 52 miles from the intake.

The catches were made on B secondary canal at a distributary 1½ miles N.W. of Monarch.

The banks of the ditch were covered with *Salsola Kali* and *Sisymbrium altissimum.*

Weeds prevalent in the vicinity were:

Thlaspi arvense L.
Salsola Kali L.
Sisymbrium incisum Engelm.
Sisymbrium altissimum L.

Analysis of Weed Seed Catch

Table 5.

1st Catch June 9th, 1925

Trap submerged ½ diameter.
Width of water 12½ ft.
Depth of water 2 ft. 11 in.
Velocity of water 2 miles per hour.

Number of weed seeds passing per 24 hours on the surface and to a depth of 1.57 inches.

Cyperacae	440
Chenopodium album L.	1760
Amaranthus retroflexus L.	4400
	6600

2nd Catch June 9th, 1925.

Same location and conditions as 1st Catch.

Brassica juncea (L) Cosson 440

3rd Catch. June 9th, 1925

Same location and conditions as 1st Catch.

Nil.

4th Catch. June 9th, 1925.

Same location and conditions as 1st Catch.
Trap all submerged, at a depth of one foot.

Lepidium sp. 2731

5th Catch. June 9th, 1925.

Same location and conditions as 1st Catch.

Nil.

Iron Springs, 9 miles east of Keho Lake, also on the Lethbridge Northern Irrigation System was visited on July 28, 1925.

On the ditch banks were found masses of *Sisymbrium altissimum* and on the land adjoining:—

Salsola Kali L.
Rumex crispus L.
Hordeum jubatum L.
Lappula echinata Gilib.
Cirsium arvense (L) Scop.
Solidago sp.
Lactuca pulchella (Pursh) D.C.
Sonchus arvensis L.
Grindelia sp.
Thlaspi arvense L.
Bouteloua oligostachya (Nutt) Torr.
Malvastrum coccineum (Pursh) Gray

Western rye grass was noticed as having been sown on the ditch banks but was not established.

Analysis of Weed Seed Catch

Table 6.

6th Catch. July 28th, 1925.

Trap all submerged at surface of the water. Location on Turin Branch, 52 miles from the intake and 9.4 miles from Keho Lake. Width of water 17½ ft. Depth of water 3½ ft. Velocity of water 1 mile per hour.

Number of weed seeds passing per 24 hours on the surface and to a depth of 3.25 inches.

Hordeum jubatum L.	545,676
Salsola Kali L.	136,419
Rumex crispus L.	51,618
	733,713

Analysis of Weed Seed Catch

Table 7.

7th Catch. July 28th, 1925.

Same location and conditions as 6th Catch.
Trap all submerged.

Number of weed seeds passing per 24 hours on the surface and to a depth of 3.25 inches.

Hordeum jubatum L.	9,254
Rumex crispus L.	2,644
Thlaspi arvense L.	11,898
	23,796

Analysis of Weed Seed Catch

Table 8.

8TH CATCH. July 28th, 1925.

Same location and conditions as 6th Catch.

Trap submerged ½ diameter.

Number of weed seeds passing per 24 hours on the surface and to a depth of 1.57 inches.

Rumex crispus L.	1,650
Hordeum jubatum L.	1,650
Lotus sp.	11,898
	15,198

On August 17th, 1925, a visit was made to the United Irrigation District at Glenwoodville, south of MacLeod. This is an independent system, and the water is obtained from the Belly River. This irrigable area is 36,000 acres, and the water is carried by 10 miles of main canal, 5.7 miles of main lateral and 157 miles of lateral ditches.

In the district were observed:—

Lupinus perennis (L) Willd.
Aster sp.
Thlaspi arvense L.
Artemisia frigida Willd.
Gaillardia aristata Pursh.
Hordeum jubatum L.
Chenopodium album L.
Grindelia sp.
Helianthus sp.
Potentilla sp.
Rosa arkansana S. Watts.
Polygonum aviculare L.
Solidago sp.
Hedysarum sp.
Avena fatua L.
Cirsium undulatum (Nutt) Spreng
Lactuca pulchella (Pursh) D.C.
Liatris squarrosa Willd.
Polygonum Convolvulus L.
Chrysopsis villosa Nutt.
Lygodesmia juncea (Pursh) D. Don
Bouteloua oligostachya (Utt) Torr.
Cirsium arvense (L) Scop.
Achillea millefolium L.

Avena, Thlaspi arvense and *Cirsium arvense* are abundant in the district, particularly the first named.

Analysis of Weed Seed Catch

Table 9.

9TH CATCH. August 17th, 1925.

Trap submerged ½ diameter.

Location on farm lateral west of Glenwoodville.

Width of water 6 ft.

Depth of water 2 ft.

Velocity of water ½ mile per hour.

Number of weed seeds pasing per 24 hours on the surface and to a depth of 1.57 in.

Nil.

Analysis of Weed Seed Catch

Table 10.

10TH CATCH. August 17th, 1925.

Trap submerged ½ diameter.

Location on branch canal west of Glenwoodville.

Width of water 8 ft.

Depth of water 2 ft.

Velocity of water 1 mile per hour.

Number of weed seeds passing per 24 hours on the surface and to a depth of 1.57 inches:

Cirsium arvense L.	2610
Thlaspi arvense L.	1305
Avena fatua L.	435
Lactuca pulchella (Pursh) D.C.	3825
Hordeum jubatum L.	11745
	19920

Another irrigation district which was visited was that at Coaldale on August 27, 1925. This is known as the C.P.R. Lethbridge, and lies 10 miles east of Lethbridge. The source of supply is the St. Mary's River and the intake at Kimball.

The investigation was carried out 3 miles N.E. of Coaldale. The weeds observed in this locality were similar to those observed on the other schemes in the Lethbridge area, with the addition however of Perennial Sow Thistle.

Analysis of Weed Seed Catch

Table 11.

11TH CATCH.

Trap submerged ½ diameter.

Location at fork to lateral on branch canal 3 miles N.E. of Coaldale.

Width of water 15 ft.

Depth of water 1½ ft.

Number of weed seeds passing per 24 hours on the surface and to depth of 1.57 inches.

Cirsium arvense L.	28,482
Rumex crispus L.	6,060
Hordeum jubatum L.	3,636
Mentha sp.	1,545
Polygonum sp.	2,727
Salsola Kali L.	606
Lactuca pulchella (Pursh) D.C.	606
Melilotus sp.	7,878
Polygonum Persicaria L.	909
Erysimum cheiranthoides L.	303
Agropyron sp.	1,212
Cruciferae	2,424
Chenopodium album L.	606
	56,994

On September 2, the Taber area was revisited on account of the fact that the ditches were dry on the previous visit.

The opinion of some of the farmers in the district is that Wild Oats if not checked, are becoming so bad as to threaten the growth of grain altogether. On this visit it was observed that many of the weeds on the ditch banks had been cut. In addition to the weeds previously enumerated for this district, the following were also noticed:

Lactuca pulchella (Pursh) D.C.
Lactuca scariola L.
Polygonum Persicaria L.
Lepachys columnaris (Sims) T. & G.

Canada Thistle is very abundant in the district.

Analysis of Weed Seed Catch

Table 12.

12th Catch. September 2nd, 1925.

Trap submerged ½ diameter.

Location on branch 2 miles south, ½ mile west of Taber.

Width of water 10 ft.
Depth of water 15 inches.
Velocity of water 2 m.p.h.
Velocity of wind 15 m.p.h.

Number of weed seeds passing every 24 hours on the surface and to a depth of 1.57 inches.

Rumex crispus L.	606
Cirsium arvense (L) Scop.	13,635
Agropyron sp.	303
Beckmannia erucaeformis (L) Host	5,151
Polygonum Persicaria L.	3,333
Polygonum aviculcare L.	606
Rumex persicaroides L.	1,515
Lactuca pulchella (Pursh) D.C.	303
Mentha sp.	2,121
Hordeum jubatum L.	158,055
Potentilla sp.	9,999
	195,627

Analysis of Weed Seed Catch

Table 13

13th Catch. September 2nd, 1925.

Same location and conditions as 12th Catch.

Number of weed seeds passing per 24 hours on the surface and to a depth of 1.57 inches.

Hordeum jubatum L.	391,050
Rumex crispus L.	84,150
Lactuca pulchella (Pursh) D.C.	69,300
Amaranthus retroflexus L.	321,750
Rumex persicariodes L.	306,900
Sisymbrium altissimum L.	4,950
Mentha sp.	110,880
Potentilla sp.	172,200
Beckmannia erucaeformis L. (Host.	153,450
Cirsium arvense (L) Scop.	14,850
Salsola Kali L.	29,700
Polygonum sp.	9,900
Polygonum Convolvulus L.	4,950
	1,674,030

It might be as well here to illustrate the practical effect of this flow of weed seeds on the contamination of the land. With the data as to width and depth of ditch, rate of flow of water, etc., given above, (the banks of the ditch have an angle of 1.5:1) and assuming that the flow of weed seeds as shown by the catch, is uniformly distributed over the cross section of the ditch at that point, this is equivalent to a deposition of 170,800 weed seeds per acre in one 6″ irrigation.

Monarch was visited again on September 17. Weeds were very prevalent, *Hordeum jubatum* being very noticeable in addition to those previously mentioned. The growth of

ıll weeds was very rank, while hundreds of ıcres of Tumbling Mustard testified to the xtent of the infestation.

Analysis of Weed Seed Catch

Table 14.

4TH. CATCH. September 16th, 1925.

Trap half submerged.

Location on secondary canal 4 miles north f Monarch.

Velocity of wind 20 m.p.h.

Velocity of water 2 m.p.h.

Number of weed seeds passing per 24 ours on the surface and to a depth of 1.57 ıches.

Hordeum jubatum L.	123,750
Lactuca pulchella (Pursh) D.C.	14,850
Polygonum sp.	23,400
Beckmannia erucaeformis (L) Host.	14,850
Rumex crispus L.	29,700
Amaranthus retroflexus L.	99,000
Chenopodium album L.	247,500
Sisymbrium altissimum L.	14,850
Cirsium arvense (L) Scop.	14,850
	582,750

This concluded the investigation for 1925.

It was intended to do further work during e fall irrigation of 1926. Fall irrigation is especial importance in that any weed seeds rried by the water have the best possible ance to germinate in the spring before the p growth has attained sufficient size to other them.

A severe snowstorm however visited the ole of Southern Alberta on September 7, d wintry conditions prevailed for a considble time. As a result it was not possible investigate this phase except in a limited ree. It is thought that the snow and frost sed the weed seeds to adhere to the plants, reby preventing the usual dispersal of seeds and consequently affecting the weed d content of the water. The results obned in the fall of 1926 will be of value vever if considered as part of a series conied over future years.

he C.P.R. Eastern Irrigation district was in visited in 1926 but at a different loca- from that of 1924, with the following ılts:—

Analysis of Weed Seed Catch

Table 15.

1ST CATCH.

Trap submerged ½ diameter.

Location 1 mile East of Cassils on Cassils Branch Canal.

Average depth of water 1.93 ft.

Width of water 15 ft.

Wind 3 miles per hour.

Land covered with snow.

Number of weed seeds passing per 24 hours on the surface and to a depth of 1.57 inches.

Hordeum jubatum L.	899
Beckmannia erucaeformis (L) Host.	899
Rumex crispus L.	12586
Cleome serrulata Pursh.	899
	15283

Analysis of Weed Seed Catch

Table 16.

On September 17, 1926, the Lethbridge Northern Irrigation District was visited. The snow had by this time partly disappeared.

2ND CATCH. September 27, 1926.

Trap submerged ½ diameter.

Location on Monarch Branch Canal.

2 miles north of Monarch.

Width of water 24 ft.

Velocity of water 1 m.p.h.

Average depth of water 1.2 ft.

Velocity of wind 2 m.p.h. S.W.

Number of weed seeds passing per 24 hours and to a depth of 1.57 inches:—

Hordeum jubatum L.	10,580,000
Salsola Kali L .	10,400
Amaranthus sp.	20,800
Chenopodium album L.	31,200
Polygonum sp.	10,400
Rumex crispus L.	52,000
	10,704,800

Analysis of Weed Seed Catch

Table 17.

3RD CATCH. September 28, 1926. 9-11 a.m.

Trap submerged ½ diameter.

Average depth of water 14 inches. Wind calm.

Width of water 24 ft.

Velocity of water 1 m.p.h.

Number of weed seeds per 24 hours on the surface and to a depth of 1.57 inches.

Hordeum jubatum L.	71,344
Rumex crispus L.	8,918
Chenopodium album L.	8,918
	89,180

A visit was then made to the C.P.R. Lethbridge Project and the following catches were made at points not previously investigated.

Analysis of Weed Seed Catch

Table 18.

4TH CATCH. September 29, 1926. 10.15 a.m. to 1.45 p.m..
Trap submerged ½ diameter.
Location Chin No. 2 Canal.
Width of water 12 ft.
Average depth of water 1 ft.
Velocity of water 1 m.p.h.—of wind 8 m.p.h.

(Note—The headgates are situated at Kimball, a distance of 80 miles S.W. of here.)

Number of weed seeds passing per 24 hours on the surface and to a depth of 1.57 inches.

Sisyrinchium angustifolium Mill.	2,973
Polygonum Convolvulus L.	2,973
Melilotus officinalis (L.) Lamb.	11,892
Rumex crispus L.	38,649
	56,487

Analysis of Weed Seed Catch

Table 19.

5TH CATCH. Sept. 29, 1926. 2.50-3.50 p.m.
Trap submerged ½ diameter.
Location on the N.E. lateral.
7 miles N.E. of Lethbridge.
Velocity of wind 3 m.p.h.
Width of water 24 ft.
Average depth 19 inches.
Velocity of water 2 m.p.h.
Velocity of wind 3 m.p.h.

Number of weed seeds passing per 24 hours and to a depth of 1.57 inches.

Melilotus officinalis (L) Lamb.	1,581,440
Polygonum Convolvulus L.	423,600
Sisyrinchium angustifolium Mill.	225,920
Erigeron canadensis L.	112,960
Xanthium canadense Mill.	56,480
Rumex crispus L.	1,327,280
Amaranthus sp.	649,520
Chenopodium album L.	960,160
Hordeum jubatum L.	28,240
Thlaspi arvense L.	112,960
Polygonum sp.	112,960
Cirsium arvense (L) Scop.	56,480
Lappula echinata Gilib.	28,240
Galium boreale L.	56,480
Thalictrum dioicum L.	28,240
	5,760,960

Table No. 20 shows the number of wee seeds per acre being distributed by the wate at the time the catches shown in tables 15-1 were made, calculated on the same basis a was done for the investigation at Taber.

The possible distribution of weed seeds pe acre was calculated from the catches obtaine

Table 20

1926 Catch	Weed Seeds Found	Weed Seed per Acre
1	17	279
2	1029	84,063
3	10	817
4	19	359
5	205	21,717

It has previously been remarked that the time these catches were made conditio were unfavourable to plants shedding the seeds. In spite of this, however, two of th catches show the possibility of serious co tamination.

In catch No. 2, 83,089 of the seeds pe acre were Wild Barley, formerly consid ered noxious and still considered a ve bad weed. Suppose a sample of Western Ry grass seed, for example, were to contain su ficient of these seeds to contaminate the lan to this degree when planted at the rate o 15 pounds per acre; it would consist of nea ly 4% of the seeds of Wild Barley, and n farmer would ever think of sowing it if h knew the seed was so dirty.

In the case of Catch No. 5, we have Curle Dock, a noxious weed under the Seeds Ac being distributed at the rate of 5003 see per acre. This would be equivalent to sow

ing Alfalfa, for instance, at a rate of 8 lbs. per acre, which contained about 40 seeds of this per ounce, or in other words to the use of grade No. 3 seed; and this without taking into account the other weed seeds, many of them noxious.

It has been suggested that, owing to their sodden condition, weed seeds flowing in irrigation water for any considerable time would not germinate. In 1924 a few weed seeds taken from the "catches" were tested in our seed laboratory and all showed good viability. This point was further investigated in 1925 with the following results, the seeds being obtained from the investigation work of that year:

Table 21.

Kind of Seed	Germination per cent. After 4 days	After 7 days	After 55 days
Hordeum jubatum L.	0	89	89
Rumex crispus L.	4	4	48
Amaranthus retroflexus L.	33	37	40
Polygonum Persicaria L.	0	0	1
Cirsium arvense (L) Scop.	4	4	26
Salsola Kali L.	83	90	90

(Note—*A. retroflexus* and *P. Persicaria* are admitted as having usually a high percentage of "hard" or impermeable seeds.)

From the data obtained in this investigation is apparent that the weed evil is much more rious when regarded in its relation to irriition. The water applied in irrigation, ten needed for crops, would also produce nditions peculiarly suitable for the germinan of weed seeds. The greatest danger lies the water applied for fall irrigation, as is water contains newly ripened weed seeds their most abundant season and also due the fact that moisture would remain in the l during the winter, thereby ensuring fav-rable conditions for germination in the ing.

The officials in charge of these irrigation emes seem quite aware of the danger ought to notice in this investigation, partly account of the weeds being introduced on the land under irrigation under such fav-able conditions for germination and also ause of its being a possible deterrent fac- in increasing the number of users of gation water.

t seems probable that when the several npanies are in a better financial position, ater attention will be paid to this ques- and that the farmers themselves will lize that the reduction of weeds on their d by mutual effort will be to their material antage.

gginton, in the article previously men-ed, recommended the seeding of Brome ss (*Bromus inermis*) on the ditch banks ome instances as a means of crowding out weeds. It is conceivable however that Brome might act as an objectionable weed under certain conditions. Possibly no general recommendation can be made as the different types of ditches as well as their different locations will have a bearing on this question. However, Egginton reports that where ditch banks have been grazed Kentucky Bluegrass often becomes dominant. It may not be feasible yet to fence and graze the ditch banks, but possibly seeding them down to a mixture of Kentucky Bluegrass, Western Rye and Timothy would enable the first of these to become established, which would effect a partial measure of control. Red Top and White Clover might often be added to this mixture to advantage.

Until the grasses get established the weeds should be cut at intervals and especially at the time of flowering. The weed problem on the land adjoining, which is a contributary factor to the number of weed seeds in the water, would have to be treated by an educational policy. If the farmers on irrigated areas understand this danger and realize how much depends on individual effort, much will have been accomplished. Every irrigation district in Southern Alberta is affected by the prevalence of weeds and in a few instances some very noxious weeds have been observed, which if not checked, will prove a menace to farming generally.

During the course of this investigation it has been found that contamination of the irrigation water is worse when high winds are blowing and where the physical features of

the territory allow these winds to sweep without interruption for great distances, such as prevails in the prairie. The banks of the ditches, being higher than the surrounding area, cause the arrest of wind dispersed seeds and in time these blow into the canals.

It will be seen, also, that in some cases, water used is brought a great distance and during its flow passes abandoned farms and land which has at some time been under cultivation. This is a fruitful source of weed seeds. This problem will in time, however, solve itself as the plant associations natural to prairies will re-establish themselves in due course. Some authorities are of the opinion that this may take place within eight years.

This investigation is in no way to be regarded as critical of irrigation *per se* but rather as pointing out the evil of letting weed conditions get beyond control.

It is a pleasure to acknowledge the courtesy and cooperation received from Mr. Griffen of the C.P.R. Engineering Department, Brooks, Mr. Houston of the C.P.R. District at Lethbridge and Mr. Sauder of the Lethbridge Northern District while engaged on the investigation.

GLOSSARY

Achillea millefolium—Yarrow.
Agastache Foeniculum—Giant Hyssop.
Agropyron sp.—Wheatgrasses.
Amaranthus retroflexus—Red-root Pigweed.
Antennaria canadensis—Everlasting.
Artemisia biennis, Artemisia frigida—Wormwood.
Aster sp.—Aster.
Astragalus sp.—Milk Vetch.
Avena fatua—Wild Oats.
Beckmannia erucaeformis—Beckmann's Grass.
Brassica juncea—Brown Mustard.
Bouteloua oligostachya—Mesquite or Grama Grass.
Chenopodium album—Lamb's Quarters.
Chrysopsis villosa—Golden Aster.
Cleome serrulata—Spider Flower.
Cirsium arvense—Canada Thistle.
Cirsium lanceolatum—Common or Bull Thistle.
Cirsium undulatum—Wavy-leaved Thistle.
Conringia orientalis—Hare's Ear Mustard.
Cyperus sp.—Galingale.
Draba nemorosa—Whitlow Grass.
Epilobium angustifolium—Willow Herb.
Erigeron canadensis—Fleabane.
Erysimum asperum—Western Wallflower.
Erysimum cheiranthoides—Wormseed Mustard.
Gaillardia aristata—Blanket Flower.
Galium boreale—Bedstraw.
Gaura coccinea—Butterfly Weed.
Grindelia sp.—Tarweed.
Hedysarum borealis—Hedysarum.
Helianthus sp.—Wild Sunflower.
Hordeum jubatum—Wild Barley.
Lactuca pulchella—Blue Lettuce.
Lactuca scariola—Prickly Lettuce.
Lappula echinata—Stickseed.
Lepachys columnaris—Coneflower.
Lepidium sp.—Peppergrass.
Liatris squarrosa—Blazing Star.
Lotus sp.—Bird's Foot Trefoil.
Lupinus perennis—Wild Lupine.
Lygodesmia juncea—Prairie Pink.
Malvastrum coccineum—False Mallow.
Melilotus sp.—Sweet Clovers.
Melilotus officinalis—Yellow-flowered Sweet Clover.
Mentha sp.—Mint.
Oxytropis Lamberti—Loco Weed.
Phlox subulata—Ground Moss.
Polygonum aviculare—Knot Weed.
Polygonum Convolvulus—Wild Buckwheat.
Polygonum Persicaria—Lady's Thumb.
Potentilla monspeliensis—Cinquefoil.
Ranunculus Cymbalaria—Sea-side Crow Foot.
Rosa arkansana—Prairie Rose.
Rumex crispus—Curled Dock.
Rumex persicaroides—Golden Dock.
Salsola Kali—Russian Thistle.
Sherardia arvensis—Blue Field Madder.
Sisymbrium altissimum—Tumbling Mustard.
Sisymbrium incisum—Tansy Mustard.
Sisyrinchium angustifolium—Blue-eyed Grass.
Solidago sp.—Golden Rod.
Sonchus arvensis—Perennial Sow Thistle.
Thalictrum dioicum—Meadow Rue.
Thlaspi arvense—Stinkweed.
Vicia americana—American Vetch.
Xanthium canadense—Cocklebur.
Zygadenus—White Camas.

Standing Timber Insurance.

G. R. LANE

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The insurance of standing timber against loss by fire is bound to come into Canada within the next few years. Policies will be placed on young, artificially-made plantations, farmers' woodlots and blocks of timber hat are growing rapidly or reaching maturity. t is very doubtful whether large holdings will ever be insured, because 92 per cent of he forest land is owned by the people of Canada, through the Dominion or Provincial Governments, and only 8 per cent is privately wned. Licenses to cut have been granted on 2 per cent of the public forest area, but as ompanies holding such licenses have to pay ues and royalties only on what they cut, they re not likely to place insurance.

In Europe, forest fire insurance is not a ew thing, but the companies there have not nade much money in this line until recent ears and the proportion of forest insured is ill small. This is probably because a large roportion of the forests there are State wned. However, in the Scandanavian counies much insurance has been written of rent years. It was not until 1916 that any mpany in America was prepared to take sks on standing timber. In 1917 a group of ne companies and private individuals agreed form the Timber Lands Mutual Fire Insurce Company of Portsmouth, N.H., and subribed a $50,000 guaranteed reserve.

The organization had examined the fire rerds of 30 private associations, 15 state partments, and the United States Forest rvice, over a period of six years and found at the loss in any one year did not exceed ore than one-half of 1 per cent, and in some tricts was much less. The cost of management was figured at one-half of 1 per cent, ich is the usual cost of doing business in urance companies. The first year 67 polis were written on a flat rate of 2 per cent at the end of the first year this was reed to 1¾ per cent and a further reduction 1½ per cent was contemplated when the iness was sold to the Globe-Rutgers Co.

t is difficult for a new company to comnce business in any state or province as the s permitting the formation are very strict often vary between states and provinces. npanies are often put to great expense and ible to comply with these laws and usually large reserves of capital are required. However, there are now three companies actively engaged in writing forest fire insurance and it is expected that these will soon be followed by more.

It has been found that standing timber insurance appeals to owners against total loss after they have waited years for the crop to mature. Another class which takes advantage of insurance are those with artificial plantations that were planted at considerable expense and are in locations that warrant considerable money being spent on protection and insurance. Others wish to hand down fast growing timber to their relatives who will reap the benefit of years of growth, and are willing to pay the premium as a protection against loss by fire.

Timber owners, who desire to borrow money on their limits, find that they often are given a lower rate of interest when they file with the bank a standing timber insurance policy for the limit in question. It is said that some banks make insurance obligatory when they learn that timber land insurance is available.

The rates of insurance on green timber vary in the same way that automobile insurance varies, namely, according to the risk. When the first company was formed in 1917, little attention had ever been given to the rate at which fire travels in pine plantations, mature stands or mixed stands of conifers and hardwoods, and so it was a matter of guess work in most cases as to the rate which would be charged. Now that a little more is known about such matters, rates vary from 1¼ to 2½ per cent for merchantable standing timber, and from 2 to 3½ per cent for plantation insurance. At first glance this latter rate looks to be excessively high and it is hoped that it may still prove to be such, but it has been found that when a fire gets into a plantation, it burns with such intense heat that it immediately sets up its own draft and consumes all vegetation. This means a total loss as all the trees are too small to have any salvage value.

Old stands prove to be the best risk because they are more resistant to rapid spread of fire particularly where the woods have been well cared for or are a mixture of conifers and

hardwoods. Mature stands are seldom a complete loss and often have a high salvage return, particularly if near a ready market and the damaged timber is immediately cut. With mature stands a fire that would be hot enough to totally ruin a young plantation seldom eats into the trees more than the depth of the bark. Often the whole of the mature trees can be saved if cut before fungus and wood boring insects ruin the trees. The maximum rate is usually charged on conifer woods between the ages of ten and thirty years.

Second cuttings are always a more dangerous risk on account of the accumulations of slash from the first cutting and the presence of many young trees that usually become a complete loss when burned.

Risk varies with the kind of growing timber, the climate, soil, topography and the location. Bad locations are those close to a railroad right-of-way, to a recent slash, or to portable mills, along tourist routes, along public highways and close to large cities and picnic grounds. Risk may be reduced greatly by proper improvements and protection.

The companies have to deal with the man who only wants to take out a policy in a dry season and cancels his policy at the end of it, not giving the companies the benefit of a wet season. It was found necessary to raise the premium of such owners. Companies also found it necessary to insert a clause in the policy, making it obligatory on the part of the owner to acquaint the company on the addition of anything that would increase the risk, such as the establishment of portable mills, lumber camps or large areas of slash, on or in proximity to the area insured.

Companies find that it is necessary for them to make periodical inspections to check up on the policy holders. It is found to be bad policy to insure continuous tracts of timber unless they are separated by an occasional lake or wide stream. Usually blocks at half mile intervals are insured for their full value.

As boundary lines on areas on which insurance was asked, were often badly defined or badly run, there was much difficulty in locating the areas and often disputes arose between the owner and the company as to the exact location and value of timber to be insured. The rule now is to accept the owner's valuation after the company has ascertained the risk involved by making a general survey of the whole property. A clause binds the policy holder to an approximately correct value of his stand. If he over-values it he is paying a useless premium, and if he undervalues it, he is not getting all the protection he desires.

Final settlement is made on the actual value of the timber destroyed as found by the company adjuster. In cases of dispute, the company reserves the right to pay the value of the lot as estimated by the owner when the policy was taken out, and the company can salvage the tract itself.

Set rates are usually stated and extra risks are charged where a lot is close to a railroad, bad slash or other hazards which tend to make bad forest fires. Credits are given in the form of reduced rates where fire patrols exist or where the property has the protection of government fire fighting apparatus, lookout towers, placards, etc.

No doubt rates will still decline after more investigations are made regarding the prediction of fire-weather and greater care taken to guard against fire during such weather. But the great bugbear of all companies will be one of those fire years such as occurred in 1911, 1916 and 1923, when the weather stays so dry for weeks at a time that fires in different parts of the country do great damage in spite of all the care and pains taken to guard against their inception.

In Europe it is demanded that the policy continue for at least ten years and that the owner insure all his holdings in one company. The amount and nature of protection which the policy holder is to give the property is stipulated in the policy.

Companies hesitate to take policies where lack of protection, roads and market make it impossible to quickly cut and sell timber injured by fire. It is only since the Great War that companies are making any attempt to salvage burned-over limits quickly. In most cases such timber has been left a total loss.

Timber in Canada is the only thing with any great value that has not as yet been insured. Considering that our merchantable forest area covers 456,000 square miles, it will be seen what a vast field of insurance still remains to be opened up. The time may not be far distant when forest actuary will be taught in our universities, but considerable more money must be spent investigating matters pertaining to the forest before companies can be expected to enter into insurance of standing timber on any very large scale.

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Le Nitrate de Soude.*

Sa valeur agricole comme engrais.

GEORGES GILBERT

Station Expérimentale Ste-Anne de la Pocatière, P.Q.

Dans la Province de Québec il faudrait intensifier un peu notre agriculture et augmenter nos rendements. Parmi les divers moyens à prendre pour atteindre ce double but, l'un des premiers consiste à conserver et augmenter la fertilité du sol. Et c'est alors que si les applications de fumier de ferme, le système de rotation suivi, les engrais verts enfouis ne nous donnent pas satisfaction sous le rapport de la fertilité, il faut de toute évidence, avoir recours aux engrais chimiques réclamés par le sol et en particulier au Nitrate de soude, parce que comme le dit Grandeau, le nitrate sert directement à l'alimentation de la plante.

Fonctions de l'azote dans la vie végétale;

L'azote est un des élèments le plus employé par les plantes, il est une partie essentielle de la matière vivante des cellulues (protoplasma), il stimule le pousse des tiges et des feuilles (parties végétatives) et lorsque l'on sait que l'élaboration de la sève se fait dans les feuilles on comprend que la croissance générale de la plante soit déterminée par la proportion d'azote qui sera à sa portée.

Besoin des sols de la Province en Azote.—

Indications fournies par l'analyse chimique;

"Sur 57 échantillons de terre analysées au Laboratoire Provincial, 4 seulement furent trouvés insuffisamment pourvus d'azote" (Rapport du Dr. A. T. Charron au Ministre de l'Agriculture, P.Q. 1922-1923). Cependant nous savons que l'azote du sol n'est pas tout entier sous une forme assimilable par les plantes. Par conséquent une terre que l'on soumettrait à l'analyse pourrait nous indiquer par un pourcentage élevé—jusqu'à 2,6% dans les terres humifères—qu'elle est riche en azote et, néanmoins les plantes pourraient souffrir d'un manque d'alimentation azotée. On voit donc que l'analyse chimique, au point de vue "nourriture assimilable" par les plantes, fournit des indications qui ne sont pas toujours suffisantes.

Indications fournies par l'aspect physique du sol et la végétation.

Les terres humides peuvent renfermer un surplus d'azote, mais le manque d'aération et l'acidité mettant obstacle à la nitrification et l'azote ne peut devenir assimilable tant que les conditions sont défavorables. D'une manière générale on peut dire que tous les sols naturellement dépourvus ou appauvris en humus par la culture prolongée, que toute terre de couleur pâle par suite de l'oxydation de leur humus bénéficieraient d'un apport d'engrais azoté. L'aspect de la végétation des terres donne encore des indices qui ne peuvent guère tromper. Si les plantes sont maladives, les feuilles rabougries et jaunâtres au lieu l'être vert-foncé on peut conclure au manque d'azote.

Ce qu'est le Nitrate de Soude.

Le Nitrate de Soude ($NaNO_3$), que l'on appelle aussi Salpêtre du Chili, contient quand il est chimiquement pur 16.47% d'Azote. Le nitrate de soude du commerce contient généralement 15% d'azote. Il existe des dépôts considerables de "*caliche*" dans le nord du Chili, en particulier dans la plaine connue sous le nom de "Pampa Salitrera", à des profondeurs variant de 2 à 10 pieds de la surface du sol. C'etst un sel très soluble dans l'eau et c'est parce qu'il absorbe facilement l'humidité que l'on recommande de le conserver dans un endroit sec.

Le Nitrate de Soude dans le sol.

Où les pertes d'azote par lessivage sont réduites au minimum;

Le Nitrate de soude appliqué généralement au printemps lorsque la fréquence des pluies est moyenne ne peut pas être entrainé à de trop grandes profondeurs et, aussitôt que les pluies cessent, "l'évaporation produite à la surface de la terre ou déterminée par les végétaux ramène vers les parties supérieures du sol les liquides qui étaient descendus: le nitrate remonte donc avec eux et peut ainsi

*Ce travail a été primé dans le concours ouvert par la C.S.T.A., sous les auspices du Comité du nitrate de soude du Chili, en 1924.

revenir au voisinage des racines des plantes" (4).

Le Nitrate de Soude et les sécheresses.

On sait que sur un sol riche les plantes absorbent beaucoup moins d'eau que sur un sol pauvre: les éléments nutritifs étant plus concentrés. Or, dans nos régions, les années de sécheresses ne sont pas rares, et c'est une raison que l'on peut appeler en quelque sorte indirecte, qui milite en faveur de l'emploi du nitrate, sans compter que les plantes ayant reçu à l'aide de celui-ci une alimentation azotée assez forte, les racines se développent, croissent et deviennent assez puissantes pour aller chercher l'eau à des profondeurs de 3 à 5 pieds; ces réserves leurs permettent de moins ressentir les effets de la sécheresse. V. Garola à ce sujet dit: "Le nitrate de soude diminuant la perméabilité des terres, les maintient plus fraîches, une terre qui a reçu du nitrate se dessèche moins par les temps secs."

Le nitrate de soude et son action sur l'acidité du sol.

Si nous faisons passer un courant électrique a travers une solution de Nitrate de Soude, nous voyons s'opérer le décomposition suivante:

$NaNO_3 = Na + No_3$ — le Na se dirige vers le pôle positif, tandis que le NO_3 va au pôle négatif.

Or, dans le sol une décomposition à peu près semblable s'opère. Sous l'influence du pouvoir sélectif de la plante, le NO_3 est séparé du $NaNO_3$ et absorbé. Le Na qui constitue le résidu, en présence de l'acide carbonique du sol, se combine pour former du carbonate de sodium. Nous pouvons repré senter théoriquement cette réaction comme suit:

$$2\,Na + H_2CO_3 = Na_2CO_3 + H_2O$$

Si notre carbonate de sodium vient en contact avec de l'acide sulfurique nous aurons:
$Na_2CO_3 + H_2SO_4 = Na_2SO_4 + H_2O + CO_2$

Avec les acides humiques du sol, le carbonate de soude va devenir un humate de sodium.

L'on voit donc qu'en présence du $NaNO_3$ plusieurs acides du sol vont se trouver neutralisés.

Action du $NaNO_3$ sur les autres fertilisants.

Comme nous venons de le faire ressortir l[a] soude ne peut pas être absorbée entièremen[t] par les végétaux parce qu'elle n'entre qu[e] pour une infime portion dans la compositio[n] des tissus, mais il ne faut pas oublier que le[s] substances introduites dans le sol y réagissen[t] sur les matières qu'il renferme naturellemen[t] et que, par suite, une terre qui a reçu du nitrat[e] de soude renferme bientôt du nitrate de po[tasse] ou du nitrate de chaux (équation chimique p. 7) fournis au dépens du carbonate d[e] potasse ou de chaux contenu dans le sol. Plusieurs agronomes admettent d'ailleurs qu[e] la soude peut remplacer partiellement l[a] potasse dans bien des sols, et pour beaucoup de plantes.

Le Nitrate de Soude vs le Sulfate d'ammoniaque.

Les plantes étant capables d'absorber directement l'azote nitrique sous forme de nitrate le nitrate de soude peut donc agir immédiatement dès qu'il est en dissolution. D'après de nombreuses expériences on peut remarquer quer que le nitrate de soude employé seul donne de meilleurs résultats que le sulfate d'ammoniaque également seul: car comme le dit Déhérain: "le nitrate de soude solubilise évidemment les éléments minéraux fertilisants contenus dans la terre et les rend beaucoup plus assimilables que ne le fait le sulfate d'ammoniaque. "Et il ajoute" Il y a là une indication dont les cultivateurs doivent tirer parti; si à la rigueur ils peuvent réussir en employant le nitrate de soude, sans phosphate ni potasse et obtenir de bonnes récoltes, ils risquent de n'en n'avoir que de médiocres s'ils n'associent pas les engrais minéraux au sulfate d'ammoniaque; ce dernier répandu seul est souvent peu efficace (5).

Comme nous l'avons vu plus haut le nitrate de soude par son heureuse influence sur les composés acides du sol l'emporte sur le sulfate d'ammonique dans les terres privées de chaux....et aussi dans les terres très calcaires. Nous pouvons expliquer brièvement cette assertion par la formule suivante:
$2NaNO_3 + CaCO_3 = Na_2CO_3 + Ca\ (NO_3)_2$

Comparé au sulfate d'ammoniaque au point de vue de l'action sur le rendement, le nitrate l'emporte ainsi qu'en témoigne le tableau suivant: (5).

Provenance de l'azote.

Engrais appliques.	Charlottetown Navets 1921	Rendement à l'acre Guelph, Betterraves Fourragères 1919	Rhode Island Foin (récoltes) 1913-16
	Boisseaux	Boisseaux	Tonnes
Nitrate de Soude	790.3	841.2	8.88
Sulfate d'ammoniaque	492.4	759.2	6.81
Cyanamide	410.4	607.2	6.84

Le Dr. Shutt est à ce sujet très catégorique, quand il dit: "Si nous représentons par le chiffre 100 l'action exercée par l'azote, appliqué sous forme de nitrate de soude, nous trouvons que le chiffre représentant l'action moyenne exercée par l'azote sous forme de sulfate d'ammoniaque est 84" (Engrais pour les récoltes de la ferme, Ottawa, p. 13).

Le $NaNO_3$ n'agissant pas seulement pas l'azote qu'il renferme mais encore grâce l'action favorable qu'il exerce dans les divers cas dont nous venons de parler, il est clair que son influence doit se faire sentir par une augmentation lors de la pesée des récoltes.

C'est ce qui arrive en pratique. L'expérience de Mr. Demonchaux de l'Ecole d'Agriculture de Paraclet (Yonne) France (6) sur l'avoine confirme nos avancés. La parcelle témoin donna 16 quintaux et 7 de grain tandis que la parcelle traitée au nitrate de soude à raison de 150 kilogs à l'hectare donna 30 quintaux de grain, d'où excédent dû au nitrate: 14 quintaux.

En 1921 à Charlottetown—Station Expérimentale—le rendement des navets par acre (moyenne des parcelles en double) s'établissait comme suit (8).

parcelle témoin....	646 boisseaux
Nitrate de Soude 200 lbs.	790 "

A Kemptville (Grenville County) en 1923 une expérience sur les patates donna des résultats se décomposant comme suit: (9)

No. 1. engrais complet (300-300-100)
No. 2. Ibd mais sans nitrate.
No. 3. témoin.

A la récolte, le no. 1 donnait 115 minots à l'acre, le no. 2 105 et le no. 3 101. Le nitrate de soude a donc fait produire une augmentation de 10 minots à l'acre. Dans le même feuillet on voit que l'augmentation dûe au nitrate de soude, dans une expérience sur la Irish Cobbler, se chiffre en argent à $9.70.

Le nitrate de soude fait profiter également les jeunes arbres et conserve les vieux généralement sains. C'est ainsi qu'en Nouvelle-Ecosse, au fur et à mesure que la production fruitière augmente, on voit que la consommation du nitrate augmente aussi et cela d'une manière parallèle. (9).

En 1919 il se produisait 1.599.861 barils de pomme et en employait 500 tonnes de nitrate de soude.

En 1921 il se produisait 2. 133,901 barils de pomme, et on employait 1.500 tonnes de nitrat.e

Le nitrate de soude et les maladies des plantes.

Si l'on considère l'azote comme favorisant un bon développement radiculaire, intervenant dans la formation de la chlorophylle et dans la composition des composés quaternaires, dépendant de l'activité de cette chlorophylle on peut prévoir que l'action d'un engrais tel que le nitrate de soude est tout à fait favorable pour maintenir les plantes dans un état vigoureux.

Un milieu acide est en général propice à l'expansion des maladies. Une application de nitrate, sans négliger les autres remèdes ordinaires (rotation, égouttement, destruction des résidus), aurait donc pour effet de prévenir certaines maladies et en particulier la hernie du choux qui attaque presque toutes les crucifères.

Application du nitrate de soude.

Le nitrate de soude étant un engrais très soluble et l'azote qu'il contient immédiatement assimilable, le moyen le plus économique d'employer cet engrais est de l'appliquer, au printemps, en couverture, aussi uniformément que possible, sur les jeunes plantes pendant les premières semaines de la pousse. Toutefois il ne faut pas le répandre lorsque les feuilles sont encore mouillées par la pluie ou la rosée: cela provoquerait la brûlure du feuillage.

La dose à appliquer dépend du besoin des sols et de la plante cultivée, mais en général elle varie de 150 à 200 livres, on doit rarement dépasser 400 livres à l'acre. Ajoutons

qu'il est essentiel que le nitrate de soude ne contienne pas de morceaux plus gros qu'un pois.

Action du Nitrate sur les Primeurs.

Le nitrate agit comme un coup de fouet. On utilise cet effet immédiat lorsque l'on veut obtenir des légumes primeurs; même dans une terre riche en azote, au printemps souvent la terre est trop froide pour aider la nitrification et c'est alors qu'un apport de nitrate peut avancer la végétation de 15 jours.

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Calendrier de Controle Laitier pour l'inscription au Tableau d'Honneur canadien.

J. R. PROULX

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Dans la Revue Agronomique du mois de novembre 1926. M. le professeur W.E. Crampton publiait un tableau pour faciliter la compilation des différentes dates que l'éleveur doit avoir présentes à la mémoire lorsqu'il fait du controle en vue de l'inscription au Tableau d'Honneur canadien lequel comporte une lactation de 305 jours avec mise-bas en dedans de 400 jours à partir du vêlage précédent. Dans le même but nous avons préparé un calendrier qui pourrait aussi être de quelque utilité.

Ce calendrier se compose de deux disques superposés et de grandeur différente tournant, indépendamment l'un de l'autre, autour d'un centre commun. Sur le pourtour du disque le plus grand sont distribués les douze mois de l'année divisés en autant d'espaces égaux qu'il y a de jours dans le mois, soit 365 espaces pour toute l'année.

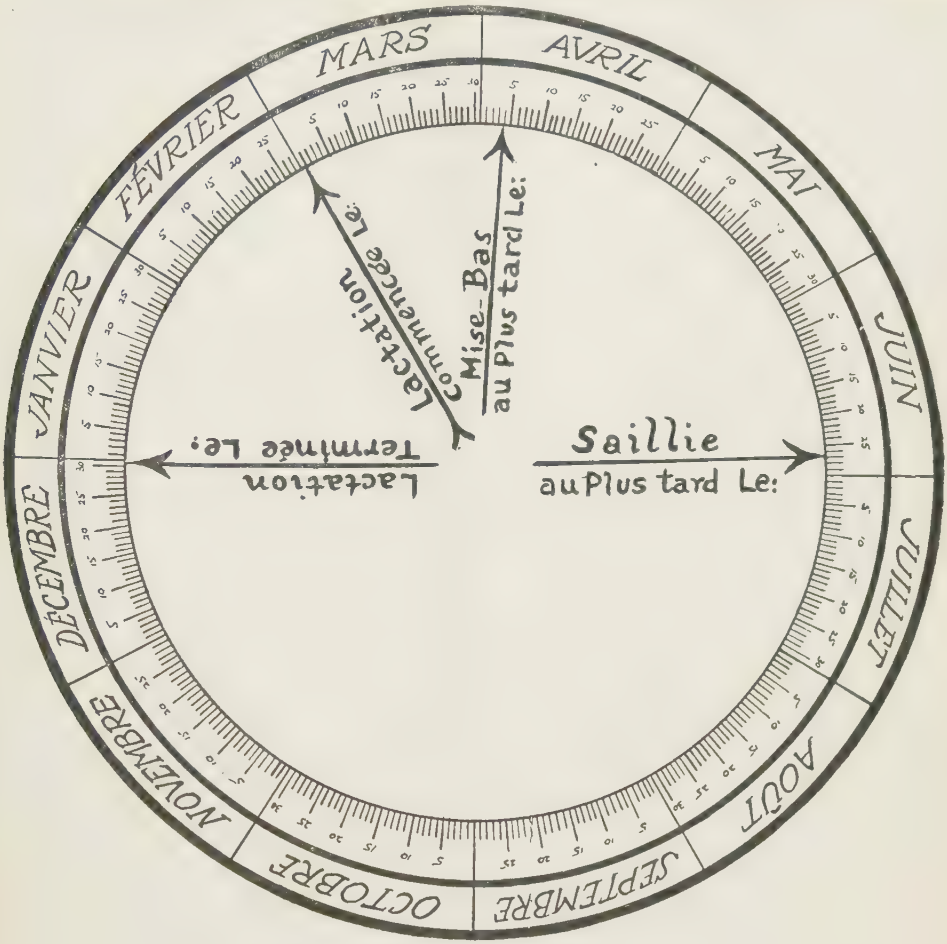
Le disque de moindre dimension est délimité par la circonférence centrale de la figure ci-dessous. Sur ce disque ont été dessinées quatre flèches inégalement distancées et portant les indications suivantes: (a) "Lactation commencée le..." (b) "Saillie au plus tard le..." (c) "Lactation terminée le..." (d) "Mise-bas au plus tard le..."

Pour se servir de ce dispositif, il faut en premier lieu ajuster la flèche marquée "Lactation commencée le..." vis-à-vis de l date à laquelle la lactation a été commencée remarquons que cette date est aussi la dat du vêlage au commencement de la période d lactation. En jetant ensuite un coup d'oe sur les autres flèches on aura les dates co respondant à chacune des indications qu nous venons de donner.

Un exemple concret illustrera mieux l chose: supposons qu'une vache a commenc sa lactation le premier jour du mois de mars pour faire la compilation désirée, on tou nera d'abord le disque central de façon ce que la flèche "Lactation commencée le..." se trouve vis-à-vis de la première barre d mois de mars; en consultant alors les autre flèches, on saura que pour vêler en dedan de 400 jours cette vache devra être saillie a plus tard le 27 juin, que son dernier jour d lactation officielle sera le 30 décembre et qu la période de 400 jours allouée entre le deux vêlages se terminera le 4 avril (d l'année suivante).

Les deux flèches portant les indicatio "Saillie" et "Mise-bas" peuvent aussi serv conjointement de table de gestation.

Le précision de cet instrument dépend d sa construction et pour qu'il soit pratiqu il faut que les deux disques soient bien ce trés et que les espaces allouées à chacun d jours de l'année soient toujours égaux.



ACTIVITES DES SECTIONS

LA FERME ET LA FERMIERE

ıe conférence de M. Alphonse Desilets, aux membres de la section de Sainte-Anne de la Pocatière, Québec.

Le 19 février dernier la section locale de Société des Agronomes réunissait ses mbres et plusieurs autres techniciens ricoles, sous le présidence de M. Antonio nte-Marie, B.S.A., régisseur de la Station périmentale, pour entendre une conférence s élaborée sur "la femme dans la vie ale". M. Alphonse Desilets, B.S.A., de ébec, chef du Service Provincial de l'-nomie domestique, était le conférencier jour.

I. Sainte-Marie présenta son hôte en rapant que M. Desilets fut à l'établissement premiers Cercles de Fermières dans la province, et qu'il n'a cessé depuis d'être leur directeur officiel et leur protecteur dévoué, comme il est aussi le directeur de l'enseignement populaire agricole-ménager.

Ces Cercles sont aujourd hui au nombre de 105 et groupent près de 7000 fermières syndiquées. Ils répandent dans nos campagnes les méthodes modèles de jardinage, d'aviculture et de soins des abeilles, les petites industries domestiques, les arts ménagers et l'amour de la vie champêtre, paroissiale et familiale. Grâce à ces organisations le Ministère de l'-Agriculture de Québec diffuse les principes de l'attachement à notre vie rurale. Les Cercles de Fermières sont le complément logique des Ecoles Ménagères locales et régionales.

M. Desilets a d'abord rappelé les origines de l'oeuvre féminine rurale que l'hon. Jos.-Ed. Caron et ses sous-ministres M. Gigault et Grenier ont ajoutée aux organismes déjà existants: sociétés d'agriculture, coopératives, syndicats et cercles agricoles. Cette oeuvre était aussi urgente en notre pays qu'elle le fut en Belgique, au Danemark, en France et en Angleterre. Les premiers cercles de fermières en notre province ont été fondés en 1915, il y a douze ans.

Le but de ces groupements se résume dans leur devise "Pour la terre et le foyer". C'est-à-dire que, tout en engageant la mère de famille et ses filles à rendre la vie domestique plus attrayante et plus facile, dans les campagnes, on leur fournit les moyens de coopérer aux travaux de l'homme des champs et de réaliser des revenus et des économies dont la classe agricole a grand besoin par le temps qui court.

Car la fermière est non seulement une collaboratrice précieuse pour son mari, elle doit être aussi une conseillère prévoyante et renseignée. Ayant ordinairement plus de loisirs que l'homme, et douée d'un esprit plus inquisiteur, il lui est plus facile d'acquérir des connaissances pratiques dont l'utilisation soit profitable à son mari et à ses enfants. La femme de cultivateur comme la villageoise qui possèdent des notions précises sur la grande culture, l'élevage, la basse-cour, la laiterie, le jardinage, l'apiculture, la culture fruitière, la mise en conserves, la production de la laine et du lin, peuvent assurer le succès des travaux de culture, si elles savent exercer avec habileté leur influence en temps et lieu.

Pour augmenter la production et amender la qualité des produits du sol au Canada, d'innombrables démarches officielles ont été tentées: lois, enseignement, subventions, recherches scientifiques, expérimentation, primes accordées, concours d'émulation, et le reste. Cette propagande a réalisé des progrès, mais la dureé des résultats, n'a été garantie qu'en raison de l'intérêt pris par la femme aux expériences et aux applications faites par l'homme dans ses cultures.

Or, la femme, en face des travaux lourds et difficiles de l'agriculture substitue, aux énergies physiques qu'elle n'a pas, un esprit ingénieux dont les conceptions méthodiques portent en elles-mêmes un gage de succès. Elle n'envisage que des moyens réalisables, en vue d'une fin résolument attendue. C'est pourquoi la méthode est claire, simple et plus facile d'application; et c'est pourquoi elle e fidèlement suivie. Aussi, peut-on admire dans chaque paroisse rurale quelques établi sements agricoles modèles qui sont le résult de la coopération de la femme avec l'homm des champs, par la mise en commun des fo ces mentales et du travail physique.

Cette conférence a été suivie d'interessant discussions soulevées par les professeurs c l'école d'Agriculture de Sainte-Anne et con mentée ensuite par les agronomes présents la réunion. La section de Ste-Anne (Quebec maintient la belle activité par laquelle el s'est signalée dès le début de sa création.

NOUVELLES DE NOS MEMBRES

Nous sommes informés que monsieur Lu ien Therrien, agronome officiel du comté Missisquoi, est nommé Sous-inspecteur po les comtés de la rive nord du St. Laurent, partir de l'Assomption en descendant, av résidence probable à Louiseville.

Monsieur Richard Bordeleau, B.S.A., de promotion de 1924, de l'Institut Agrico d'Oka, est nommé assistant de monsieur F zéar Montreuil, directeur de la station e périmentale pour tabacs, de Farnham.

Nous adressons nos sincéres félicitatio à nos confrères à l'occasion de ces prom tions.

L'INDUSTRIE DES ENGRAIS CHIMIQUE AU CANADA DURANT 1925

Nous extrayons les données statistiques su vantes concernant la production et la conso mation des engrais chimiques au Canada, du ant l'année 1925, dans la revue "Chemic age". Il fut importé 22,000 tonnes de nitra de soude, mais sur ce chiffre la fabrication l'acide nitrique préleva 13,500 tonnes; 13 autres tonnes entrèrent dans la préparati des engrais composés, de sorte qu'il resta e viron 7200 tonnes qui furent employé comme engrais simple.

La production de la cyanamide de calciu (usines de Niagara) s'éleva à 90.612 tonn estimées à une valeur de $3,839,363, dont presque totalité exportée. On ne compta q 13 établissements s'occupant en ordre pr cipal de la préparation d'engrais complet six de ceux-ci se trouvaient dans l'Ontar trois dans la Nouvelle Ecosse, deux dans Colombie Britannique et un dans chacune d provinces, de la Nouvelle Ecosse et du Ma toba.

The Elimination of False Wild Oats.

A Breeding Possibility

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The practical importance of measures for ie elimination of false wild oats or fatuoids, nd the fact that the testing of any hypothe- is for their elimination must necessarily oc- upy many years, seems to justify the publi- ation without delay of a suggestion which it as not yet been possible to test to any extent. is hoped that other plant breeders interest- d in the problem of fatuoids, will be inter- sted in testing this hypothesis, so that its orrectness or falsity may be demonstrated the minimum time.

Cytological and genetical studies on the rigin of fatuoids, following on the prelim- ary studies described in *Nature* 115:677- 78, 1925 and *Scientific Agriculture* 6:303- 3, 1926, seem to indicate very clearly that tuoids arise directly from normal cultivat- l oats by any one of several different chro- osome irregularities. The peculiar condi- ons found are evidently connected with the xaploid nature of cultivated oats. Full rticulars of these findings are being pre- red for publication at an early date. From standpoint of practical agriculture the int of prime importance which emerges is at *chromosomes bearing factors for the uoid complex appear to be regularly pre- t in ordinary varieties of Avena sativa and tain other closely related species*, though til certain chromosome irregularities oc- , the action of these fatuoid factors is sked by the action of other factors which oduce the normal type. The wide-spread urrence of fatuoids and the uniformity of ir characteristic features may in itself per- os be considered a point of evidence favor- this conclusion. Further support is found he observation that varieties of oats which normally practically awnless, will under tain growing conditions produce spikelets h very large, twisted, geniculate awns on primary grains and also slightly hairy, erozygous fatuoid-like bases. Many work- have reported considerable variation in ree of awning due to environmental conditions. An extreme case was found in some plants from a pure line of Banner oats which were grown in a greenhouse at the University of Alberta during the winter of 1924-25, and which came into head during a period of very low light-intensity in March, 1925. The grains from these plants were identical in appearance with those of heterozygous fatuoids from the same variety. That this effect was due solely to environment and that the strain was really pure normal Banner, was proved by the facts that the same plant produced panicles bearing normal grains later in the year under more normal growing conditions, and that when 256 of the fatuoid-like seeds were planted out of doors that season, none produced any but normal Banner progeny. Lack of light seemed to be the most abnormal environmental factor at the time these fatuoid-like seeds were produced, but, of course, there may have been other influences also acting on the plants to produce these characters.

Though the evidence from these different sources seems to indicate that most varieties of *A. sativa* contain hidden factors for the fatuoid complex, it does not follow that all varieties contain them. Indeed, the evidence so far available from a study of different crosses of various strains of completely awnless and weakly-awned oats with *A. fatua* and fatuoids, indicates that important genetic differences with regard to these factors occur in different varieties and strains of cultivated oats. Varieties of oats that are completely awnless under any environmental conditions are quite rare, but do exist. Most workers have not regarded the distinction between these varieties and the commoner *practically* awnless varieties as being of importance. The results obtained from the crossing experiment mentioned above, however, seem to indicate that in some cases at least, the entire absence of awns is correlated with the absence of fatuoid factors. The evidence, while yet rather incomplete, is regarded as sufficient

to justify the working hypothesis that ordinary *practically* awnless varieties of oats, and weakly awned ones, contain hypostatic factors for strong awning and the fatuoid complex, but that some or all *completely* awnless strains are entirely free from these factors, and so cannot produce fatuoids except by crossing with them.

If this hypothesis is correct it will serve also to explain some of the divergent results obtained by previous workers on the inheritance of awns in *Avena* crosses.

In the crosses mentioned above, a strain of *A. sativa gigantica*, which was obtained from the Department of Plant Breeding, Cornell University, is one which seems to be genetically different from ordinary varieties of oats in regard to awns, and *ex hypothesi* is free from fatuoid factors. In the experience of the Cornell workers and myself, fatuoids have never occurred in *A. sativa gigantica*, but this negative evidence is too limited to be of value.

Considerable evidence of the correlation between absolute awnlessness and absence of fatuoids was, however, obtained during a recent visit to Russia. At the Selection Station, Petrovsko-Rasumovskoye, Moscow 8, Professor Shegalov has a number of crosses between *A. fatua* and some strains of completely awnless oats. These have the same peculiarities as the crosses of *A. fatua* x *A. sativa gigantica* mentioned above, though in crosses of the same strain of *A. fatua* with *practically* awnless varieties he has obtained the ordinary intermediate F_1 and a 1:2:1 segregation in F_2, as other workers have reported. Shegalov's results in these crosses, have unfortunately not yet been published except briefly in Russian. It is expected that they will shortly be made available in some German publication.

The awnless oats used in these crosses we of "landsorten" widely grown in Central Ru sia. Enquiries of Professor Shegalov ar other workers elicited the fact that in all the wide experience with these oats, fatuoids ha never been found, though they occur ve commonly in different imported varieti grown under the same conditions.

Unfortunately these completely awnle Russian oats are not of a very high yieldi quality. But if they are free from fatuo factors, as the evidence indicates, it shou be possible to cross them with better so and from these crosses obtain segregates co bining the desirable qualities of the latt with the fatuoid-free nature of the forme There is, of course, the possibility that ce tain chromosome linkages may exist whi will prevent this end being achieved, but t cytological evidence so far gives no indicati of this.

At any rate it seems worth while to ma the attempt. Professor Shegalov has kind supplied me with seeds of three of his aw less strains. Crosses will be made with the this year, and work with hybrids of *A. sativa* *A. sativa gigantica* will be continued. I sha be very pleased to supply a few seeds of the Russian varieties to any other workers inte ested, or Professor Shegalov would doubtle supply them in larger quantities.

Owing to the occurrence under some cond tions of awnless plants in strains which car awn factors, it may sometimes be a matter difficulty to pick out genetically awnless segr gates. Selected plants can, however, be test by growing under varied environmental co ditions, and a conclusive test can be made crossing with fatuoids or *A. fatua*.

Note: Since the above paper was written summarized account of the recent cytologic findings has appeared in *Nature* 119:49, 192

Wheat Insects in New Brunswick a Century Ago.

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The finding of Hessian Fly in New Brunswick wheat fields in the late summer of 1925 recalls reports of injury by this insect and another related to it in the early years ot settlement. Traditional stories of the destruction of crops and consequent scarcity of food have been handed down from one generation to another so that many farms of the present day have some form of the tale. So general is it in both New Brunswick and Nova Scotia that the writer has been led to search for whatever records may have been preserved to show the extent of the crop injury at that time and its cause.

Two insects appear to have injured wheat at different times and to have been more or less confused with one another, namely, the Hessian fly, (*Phytophaga destructor* Say), and the Wheat Midge, (*Thecodiplosis mosellana* Gehin). Both are supposedly of European origin and to have reached America on plant product importations. The Hessian Fly was the first to arrive, being noticed on Long Island, New York State, in 1779. The first mention found of its possible introduction to the Province of New Brunswick is in a letter written by Judge Ward Chipman of St. John to Judge Winslow of Fredericton in April, 1789, which also includes reference to one of the earliest embargoes on the importation of plant products of which there is record. After speaking of a court decision that Indian meal would be classed as 'flour' and admitted, he said:—"With respect to the Hessian Fly, there is a Captain Clements just come from New York, who, I understand, has taken some pains to inform himself respecting its operation and I have been told he says it does not touch the grain nor is communicated by it. He will be with you, I suppose, as I understand he lives in your country; from him you may learn more about it. But as to the prohibition of wheat on that account, I have always thought it right that no risque should be run."

(Winslow Papers, p. 372).

The insect became a pest in Nova Scotia at an early date and is mentioned in a letter written by Lieutenant-Governor Wentworth in 1795 to H.R.H. Prince Edward. This letter had to do with the possibility of a famine in Halifax, due to the wheat crop having been diminished by the attacks of Hessian fly.

Wheat had been scarce in Halifax before this and also along the St. Lawrence Valley, but just why does not appear. Murdoch's history of Nova Scotia mentions that in 1788 three vessels were sent by the Government to Quebec at different times to obtain wheat, but returned each time empty. In the following year (1789), mention is found that the Governor of Canada had written to the Lieutenant-Governor in Halifax saying that there was in Canada a great scarcity of bread corn and asking for any supplies of flour, meal and Indian corn available in the province by the sea. The Justices of Quarter Sessions called for a list of supplies and forwarded to the Governor a statement that there was not at that time in Halifax more flour than would suffice for three or four days.

This period of scarcity followed shortly after the great increase of population brought about by the movement of United Empire Loyalists into Canada and insects may have had nothing to do with it. It is mentioned merely to show that during the few years before mention of the Hessian Fly is found, wheat was scarce over a considerable area of Canada. Closely following, we find mention that in 1791 the Government of Nova Scotia offered a reward of a gold medal and 10 guineas for the best essay on the natural history of the Hessian Fly and for a method of checking its ravages in the fields.

The insect would appear to have been present in New Brunswick wheat fields and one method of avoiding its injuries known as early as 1792. The Diary of Colonel Nase, colonist near Woodman's Point, N.B., a copy of which is preserved in the Dominion Archives, contains the following entry:

"September 13, 1792: Sowed winter wheat, said to be proof against fly at this date on new ground."

The next reference is dated ten tears later and is the report by George Leonard, Jr., to the provincial government on the condition of agriculture in Kings County, New Brunswick, in 1803 which reads in part:—

"This county is principally agricultural and annually sends about 200 or 300 barrels of flour to market, formerly more, but the ravages of the Hessian Fly have considerably reduced the importation."

Hessian Fly in New Brunswick appears to have run its course by 1810 and then to have dropped out of its place as a wheat enemy; at least, so far as official reports go. One cause of this may have been a change in agricultural practice. All the early reports on agriculture mention the growing of winter wheat except one. The exception is the report from Queens County in 1803, which, after noting the production of winter wheat and winter rye, also mentions trial of spring wheat. These early records show that winter wheat was widely and successfully grown in the province during the first twenty years after settlement. At present, it is a crop unknown — even by tradition — to most New Brunswick farmers. The change may have been from fall to spring wheat growing. The tradition exists that because of insect injury long ago, wheat growing was abandoned and buckwheat planted in its place. Buckwheat certainly became a widely grown crop on New Brunswick farms and held its position for a long period as one of the foods most relished by Maritime people. Tradition has it that those New Brunswickers who went around Cape Horn in 1849 introduced buckwheat into California and the present Pacific Coast states, and that the gold miners in Australia wrote home for it and had a few grains forwarded by letter, thus introducing it in the island continent.

That the change in agricultural practice was not confined to New Brunswick is shown in the report of Professor J. F. W. Johnston, who was brought out from England in 1849 by the New Brunswick government to examine into the agricultural possibilities of the country. His report was printed the following year and is now somewhat rare. A copy may be found in the Legislative Library at Fredericton.

Lacking definite production records for New Brunswick, Professor Johnston cited those of Lower Canada for the years 1827, 1831 and 1844, giving the yields of wheat, oats, corn, buckwheat and barley. His summary of these states:

"That from 1827 to 1831 a gradual increase of the wheat and oat crops took place, more in proportion in the oats than in the wheat, however; while Indian corn, buckwheat and barley were nearly stationary.

"But from 1831 - 1844 a remarkable revolution took place in the kind of cropping found most profitable in Lower Canada. The growth of oats increased from three to seven millions of bushels, while that of wheat diminished from 3,400 to 900 thousand bushels. The growth of Indian corn also underwent a diminution similar to that of wheat—falling off from 339 to 141 thousand bushels.

"I am not aware of the publication of any agricultural statistics of the states of the Union which exhibit so interesting a series of changes as this. How much agricultural distress; how much disappointment and loss of crops; how many disheartened men and starving families; how many mortgages, sales and transfers of property must have preceded and accompanied so entire an alteration in the general direction of agricultural industry, and in the kinds of produce the growers were able to send to market. What is the cause of this great change? Is it the Wheat Midge and the rust that have almost driven the wheat plant from Canada?"

In Sanderson's "Field and Garden Insects" mention is found that Wheat Midge was first reported near Quebec City in 1819 and that it spread from there to the New England States a few years later and became very troublesome. The insect appears to have reached New Brunswick some ten years before Dr. Johnston made his examination into the conditions of agriculture. He looked into the history of the outbreak and left the following interesting record:—

"In the year 1841 or 1842, the wheat in this province began to be injured by destructive insects, having the appearance of very small, yellow-coloured maggots. Five or six of them were usually found within the outside covering of a single grain at the time when the crop was beginning to ripen. This single grain they entirely destroyed without appearing to meddle with any of the other grains in the same ear. Hence, in many ears

number of the grains escaped and thus the uantity of produce was diminished without t all affecting the quality of what was left.

"This insect, by some improperly called the Iessian Fly', and by others the 'Weevil', apears to be the 'Wheat Midge', it having een observed that swarms of small flies alight n the fields of wheat about the time that the ilky substance is forming in the ear and in ie manner of horse bot-flies, impregnate the :ains separately, and that the small maggots ius produced are 'Midges' in the first stage their existence.

"These insects first appeared in Sussex Vale Kings County and seem to have spread om that fertile district, as from a common ntre, all over the province. In 1844 they estroyed nearly all the wheat in the low ounds in that valley. On the high grounds the vicinity their ravages were chiefly conied to the outsides of the fields and to a mparatively small number of grains in each r. Traces of them that year extended rough the parishes of Norton, Hampton, oham and Kingston, but did not cross the ver Saint John. In the other direction they tended to Butternut Ridge, through the rish of Salisbury and into Coverdale, in e County of Westmorland. During the xt two years they spread all over the east- part of the province and extended up the iole way through the valley of the Saint hn. In 1847 the sowing of wheat was in great measure discontinued and oats were ierally substituted in its stead. The ints, in some instances, appeared among the s but did no essential damage. Up to 47 the counties of Charlotte, Northumberd, Gloucester and Restigouche had escapand good crops of wheat had been raised; that year they began to appear in Chare and Northumberland. In 1848 what little wheat was sown, when it grew up, was so much injured by the rust that their ravages could not so well be ascertained. This present year (1849), some traces of them were found in the northern parts of the province but in all other places they have, for the most part, disappeared and have left the wheat of this season entirely uninjured.

"It would appear as if the peculiarity of the seasons during the last twelve months—the severe cold of the winter and the heat and drought of the summer—had arrested for the time the ravages of this insect. It is to be hoped that its appearance in future years may have been prevented also."

Munroe's "New Brunswick", published in London in 1855, gives the wheat production of New Brunswick in 1851 as 206,635 bushels and mentions that the insect injuries prevalent at the time of Professor Johnston's report had diminished in severity.

Concerning the state of wheat during the next fifty years, almost nothing has been found in the records. In 1914 the present writer studied the available crop records of the first fifteen years of the present century and prepared graphs of acreage and production, which were published in the report on agriculture in New Brunswick for 1915. These showed a fairly regular drop in acreage of wheat and, if anything, a slightly greater drop in production from 1901 to 1913 and then a rise under the stimulus of war conditions. The records in the Canada Year Book from 1915 to the past year show a rise in production to a peak in 1918, and then a steady drop to about the pre-war average. In 1918, production was 940,250 bushels; in 1919, 623,000 bushels; in 1921, 440,724 bushels; in 1922, 396,000 bushels; in 1923, 275,000 bushels; in 1924, 205,000 bushels.

The Determination of Arsenical Residues on Apple Foliage.

F. A. HERMAN and A. KELSALL*

This summer, when determining the relative persistency of arsenic on apples at several stages of maturity, we decided to conduct a parallel experiment and obtain data as to the persistency of arsenic to apple foliage.

Treatment. The spray-fluid applied to the plots were composed of either lead arsenic powder, lead arsenate paste or calcium arsenate with lime sulphur, lime sulphur-aluminum sulphate, or Bordeaux mixture.

Method. Five hundred leaves were picked from trees throughout the experimental plots; digested with dilute nitric acid (2 per cent.) for one-half hour, and arsenic determined in an aliquot of the filtrate by the Gutzeit method.

Location of Plots. The experimental plots were located at Middleton, N.S., and Bridgetown, N.S., and comprised Wagener and Stark varieties. When collecting the leaves for a determination, an endeavour was always made to select those of a uniform size. Collections were invariably made by the same party.

The time of the last spray application, dates of collection of the leaves, and arsenic in milligrams per 1000 leaves, is shown in Table III.

The first collection of leaves in this orchard took place about 1 hour after spraying. By this time the leaves were thoroughly dry.

The percentage loss of arsenic (Table IV) in respect to the arsenicals employed, in the first and second fortnightly periods after a plication is of interest.

Results, in general, from this season's wo imply that lead arsenate powder has somewh better adhesion properties than paste lead senate when used in lime sulphur.

SUMMARY

The lead arsenates in admixture w lime sulphur show superior adhesion calcium arsenate in lime sulphur.

The arsenicals, when incorporated in aluminum sulphate-lime sulphur mixtu have a greater persistence to foliage th when incorporated in the straight lime s phur mixture.

The adherence of calcium arsenate in aluminum sulphate-lime sulphur mixture comparable to that of dry lead arsenate, superior to paste lead arsenate.

In Bordeaux mixtures, calcium arsenate more tenacious to foliage than any of arsenicals in lime sulphur.

Weather conditions, especially the amou of rainfall, are of importance when determ ing the persistence of arsenic to the apple a apple foliage. The total rainfall, recor at the laboratory from July 15th to Septem 15th was only 5.30 inches. By months—3 inches for July, 1.60 inches for August a 0.56 inches for the first two weeks of S tember.

*Presented at the Sixty-third Annual Meeting of Entomological Society of Ontario, held at the Ont Agricultural College, Guelph, November 16-17, 1926.

Table I.
Orchard at Middleton, N.S. (Chipman's).
Variety—Wagener.

Plot No.	Treatment
2 & 2A	Lime sulphur (1-40), Calcium arsenate (¾-40)
3 & 3A	" " (1-40), dry lead arsenate (1-40)
4 & 4A	" " (1-40), paste lead arsenate (2-40)
9 & 9A	" " (1-40), aluminum sulphate (2½-40) calcium arsenate (¾-40
10 & 10A	" " (1-40), " " (2½-40) dry lead arsenate (1-40)
11 & 11A	" " (1-40), " " (2½-40) paste lead arsenate (2-40
	In addition, plots 9A, 10A, 11A had hydrated lime (1 lb. to 40 gal.) added.
16	Bordeaux (2-10-40), Calcium arsenate (1-40) soda resin (1-80)
17	" (2-10-40), " " (1-40)

The trees in the various plots were given five applications of spray.

Table II.
Orchard at Bridgetown, N.S. (Walker's)
Variety—Stark

Plot No.	Treatment
1	Lime sulphur (1-60), dry lead arsenate (1-40)
2	Lime sulphur (1-60), paste lead arsenate (2-40)
3	Bordeaux (3-10-40), calcium arsenate (1-40)

These orchard plots received only one application of spray.

Table III.

elative Adhesion of Calcium Arsenate and Arsenate of Lead in Paste and Dry Forms in combination with various Fungicides on leaves from the Middleton Orchard.

Variety—Wagener.

urce and ot No.	Date of last Spray application	Date of Collection	Arsenic (as As_2O_5) per 1000 leaves
iddleton, N.S.			Mg.
lot 2	June 29	August 17	16
" 2A	" 30	" 17	32
" 3	" 29	" 17	104
" 3A	" 30	" 17	96
" 4	" 29	" 17	144
" 4A	" 30	" 17	96
" 9	" 29	" 17	208
" 9A	" 30	" 17	160
" 10	" 29	" 17	208
" 10A	" 30	" 17	192
" 11	" 29	" 17	144
" 11A	" 30	" 17	144
" 16	" 25	" 17	136
" 17	" 26	" 17	152

Table V.

Comparison of the percentage loss of Arsenic in the first two fortnightly periods between dry Lead Arsenate, Paste Lead Arsenate in admixture with Lime Sulphur and Calcium Arsenate in Bordeaux.

Time after last Application	Lead Arsenate Paste	Lead Arsenate Dry	Calcium Arsenate
	p.c.	p.c.	p.c.
First 2 weeks	62.5	57.5	40.0
Second 2 weeks	16.7	11.7	9.7

Sixty-three per cent of the arsenic applied as paste lead arsenate is lost in the first two weeks, 58 per cent. from dry lead arsenate, and 40 per cent. from calcium arsenate. In the second fortnightly period the percentage loss from the paste lead arsenate is again the highest, 17 per cent., as compared to 12 and 10 per cent., respectively, for dry lead arsenate and calcium arsenate.

Table IV.

Relative Adhesion of Calcium Arsenate, Lead Arsenate, Dry and in Paste Form, with Lime Sulphur and Bordeaux, on leaves from the Bridgetown Orchard.

Variety—Stark.

ource and lot No.	Date of Last Spray Application	Date of Collection	Arsenic (as As_2O_5) per 1000 leaves		
			Plot 1	Plot 2	Plot 3
ridgetown, N.S.			Mg.	Mg.	Mg.
lot 1	August 14	August 14	320	320	240
" 2	" 14	" 30	136	120	144
" 3	" 14	September 11	120	100	130

Important Soil-Borne Diseases of Crops in Western Canada.*

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The soil-carried diseases to which this paper particularly refers are the foot- and root-rots of our wheat and other grain crops, including the "Take-all" disease, and those caused by *Helminthosporium sativum* P.K. & B., and species of *Fusarium;* the root-rots of clover; common scab and rhizoctonia of potatoes; and wilt of flax.

With the passing of the virgin prairie, less favorable crop conditions will become more and more pronounced, and the yields often unprofitable. This has already happened in the older prairie areas of North America. Such conditions are partly due to decreased soil fertility, weeds and partly to the increase of root-rotting fungi, which accumulate in the soil as a result of continuous cropping, especially to one kind of crop. Bolley (1), speaking of the unproductiveness of the wheat lands of the North Western States, considered that the foot- and root-rots were chiefly responsible for their unproductiveness, rather than depleted fertility and toxic substances in the soil. The work of others supported this statement. In Western Canada, where continuous cropping is generally practised, there is abundant evidence that the root-rots take a large annual toll from our crops. This evidence is obtained throughout both prairie and park areas of Manitoba, Saskatchewan and Alberta.

Helminthosporium sativum is apparently the most important foot- and root-rotting organism, being widely and generally distributed throughout the wheat fields of Western Canada. This fungus also attacks barley and rye.

Ophiobolus graminis Sacc., which causes the "Take-all" disease of wheat and attacks barley and rye slightly, has been found in all three prairie provinces, and indications are that this fungus is rather generally distributed and is already causing considerable loss in certain park areas of Saskatchewan and Alberta. Collections of this disease were made from the prairie areas this year, and o from Prince Edward Island.

Species of *Fusarium* which cause foot- a root-rot of wheat and oats, are prevalent.

Other soil-inhabiting fungi are associat with the foot- and root-rot of cereals, a while these appear to be midly parasit to healthy plants, the extent of injury whi they may do as secondary pathogens is n yet determined, but forms a part of o research.

Passing on to the root-rots of the clove and alfalfa, there are two which perhaps d serve special mention at this time. A ro rot of common red clover and alfalfa, cause by *Sclerotinia trifoliorum*, and *S. libertian* has been reported by Bisby (2) who o served it on the plots at the Manitol Agricultural College. Last spring almost ever plant of common sweet clover was dead several hog pastures at the University Far Edmonton, after the mild winter of 1925-2 An abundance of sclerotia was found the tissue of these dead plants. Scleroti apparently those of *S. trifoliorum* or *S. li ertina* were also observed in the tissue some dead alfalfa plants on the Field Hu bandry plots, University of Alberta. Wit out further observation, one is unable state whether or not the Sclerotinia disea will be a serious problem to clovers in A berta or Saskatchewan.

The other soil-borne organism associate with the root-rot of sweet clover, is o which, apparently, is much more destru tive than the one causing the Sclerotin disease, and judging from its wide distrib tion and prevalence, it has been prese for some time.

Newton and Brown (3) first reported wh appears to be the disease in question Edmonton, 1923. During the winter 1925-6, hundreds of acres of sweet clove in Saskatchewan died, and farmers generall

*Paper given at the meetings of the Canadian We ern Society of Agronomists held at Edmonton, D cember, 1926.

attributed it to winter killing. A number of these cases of apparent winter killing of sweet clover were visited in both Saskatchewan and Alberta, and what appears to be the same trouble was found in all instances. Further study has since shown that a fungus is constantly associated with the lesions on the roots. Another feature which is of special interest to agronomists, is that the Arctic strain of sweet clover survived in all cases, practically no injury being found.

What appears to be the same fungus was also isolated from lesions on alfalfa and common red clover plants. Details of this study will be published shortly.

Let us next briefly consider the important soil-borne diseases of our potato crop. Rhizoctonia or stem canker probably causes by far the greatest reduction in yield, in comparison with other potato diseases. The presence of the sclerotia of this fungus on the tubers is a comparatively unimportant phase of the problem, since these can be easily killed by a simple, though laborious, treatment, and moreover outside of the Red River Valley, a serious amount of sclerotia on the tuber, is the exception. The main problem is to control the soil borne infestation.

Common scab of potato still baffles control as much as ever, even though our knowledge of the disease has increased during recent years. Seed treatment is no longer advocated as an effective control measure; indeed it would be difficult to prove it is of any value in a badly infested soil, and nearly all soils are infested to a greater or less degree with the scab fungus. The hope that sulphur would sufficiently increase the acidity of the soil has been generally abandoned, except for fairly acid soils. Evidence points that its use for the control of scab is not feasible, either from an economical or a practical standpoint, in Western Canada. The reason why clean crops are often grown in badly infested soil may be, at least partly, explained by the behavior of the lenticels of the tubers, since infection apparently occurs during early formation of these pores before they are protected by cork. (4) This leads to a consideration of the possible biological and physical factors of soil and plant, which hasten or delay formation of the protective cork cells of these pores, as well as the scab producing fungus. Nothing very definite is known about these at present, but it is evident that any soil treatment to be effective must exert its greatest influence during the critical period for infection.

Flax wilt is another important soil-borne disease. However, the isolation of resistant strains promises effective control of the trouble.

In discussing the control of the diseases mentioned, several points must be kept in mind. Nearly all our soils have sufficient organic material for some of the pathogens to persist almost indefinitely without a host crop, although some appear to grow more vigorously and perhaps produce a greater abundance of spores on a susceptible host. Again, the degree of soil infestation may vary yearly and during the season, being influenced by the available food, moisture, temperature and other factors, biological, physical and chemical. Further, root-rotting forms of *Helminthosporium*, *Fusarium*, *Ophiobolus and Rhizoctonia* have a wide host range, parasitising many wild and cultivated plants. While non-host crops escape the disease, these pathogens may still persist, although possibly to a reduced extent. For instance, an oat crop may follow with safety a wheat crop badly infested with "Take-all," and the soil infestation is assumed to be reduced.

Another fact that greatly complicates pathological studies is the different degrees of virulence which strains of the same fungus may possess under identical conditions.

Considering the natural resistance of the host, this may be absolute for a given set of conditions, or perhaps any reasonable range of conditions which may occur in our fields. But, unfortunately for the general foot- and root-rot problems in question, natural resistance of our crop varieties is, with few possible exceptions, not sufficient in field culture. Again, a crop's resistance to a disease may vary with its age, some being more susceptible toward maturity, while others earlier. The basal parts of wheat seem to be more susceptible toward maturity to a number of soil-inhabiting organisms. Temperature and soil moisture are usually the deciding factors in field culture in modifying the resistance of the host, as well as the virulence of the parasite. For instance, a wheat

plant forms a better root system at lower temperatures, while the three leading foot- and root-rot pathogens are most virulent at higher temperatures. These facts may allow the plant to escape early infection, or even favor the attack by one parasite more than another. A number of workers have pointed out that maximum damage from these pathogens results when conditions for host development are unfavorable. Soil temperature is practically beyond control in the field, but it may be possible to improve the moisture factor somewhat and in other ways assist the plant by crop and soil management practices. This would require experiments run over a term of years at several representative points.

Another important point to be kept in mind is that of seed-borne infection. Most grains, whether apparently normal or discolored, at the germ end, may carry pathogenic *Helminthosporium*, *Fusarium*, or other fungi in a dormant state. When the grains germinate these fungi grow and are in a favourable position to attack the seedling and the primary root system on which the plant must depend for several weeks before the permanent or secondary root system develops. But in this, temperature and moisture are determining factors. Injury at this time to these parts may severely stunt or blight the seedling. But if the seedling escapes the seed-borne parasites, it may be attacked at this or a later stage by the normal inoculum of the soil, and one asks what is the relative importance of the seed and soil-borne inoculum. It does suggest that some protection may be afforded the young seedling by a seed treatment.

Testing of a large number of patented fungicidal compounds, used on the seed wet or as dust, has been carried on at our laboratory and by numerous other workers, but with varying, if not indifferent, success under field conditions. Perhaps this might be expected, for it would seem the control offered by seed treatments must always have certain limits, that is to say, while the treatment on the seed may help to prevent seedling blight, the immediate effects of the fungicide can hardly be expected to control the soil-borne inoculum some distance from the grain. However, experimental evidence suggests that intensive research in seed treatments be continued in the hope of reducing seedling infection, and thus indirectly helping the plant to resist later injury. Unfortunately, we are not in a position to recommend any definite seed treatment at this time.

It would appear then, that both crop and soil management practices and seed treatment have definite limitations for the complete control of soil borne diseases mentioned of our crops. This facts leads us to consider very seriously the possibilities for securing natural resistance in suitable varieties, which, if successful, would be the simplest and cheapest way to meet the problem. Present knowledge indicates that the difficulties are great in securing varietal resistance in potatoes to common scab and Rhizoctonia, and probably less difficult in regard to the foot- and root-rots of wheat. None of our common varieties seems more than partially resistant, most of them very susceptible. Here, then, is a definite and important problem for the combined efforts of the plant pathologist and the plant breeder to synthesize gradually, if possible, resistance in suitable varieties. If resistance to stem rust can also be included we would have the ideal, an acomplishment worth millions of dollars to Western Canada. The task has its difficulties, pathologically and genetically, and cannot be done without considerable expenditure of money and time.

Only the main features of the soil-borne disease problem in Western Canada have been given, and these without any attempt at detail.

The Saskatoon Laboratory is devoting its major effort to these foot- and root-rot problems, and work is going forward on all the possible methods for control mentioned, for it may be that complete or partial control can be obtained only by the joint use of all methods.

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Windbreaks and Shelterbelts.

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Effect and Value of Windbreaks and Shelter Belts.

If the plantation is made in the form of a ;ove or a large group of trees, it may be ılled a shelterbelt, while if the plantation kes a long narrow form, it is termed a indbreak.

Windbreaks and shelterbelts retard the vel- ;ity of the wind to some extent by partly flecting the wind, causing it to veer up- ırds, leaving an area of calm on the lee le of the trees and for a short distance on e windward side as well. By retarding the nd movement, the evaporation from the soil d vegetation is lessened, the crop can make tter progress on the same amount of rain- ll, erosion of the top soil is lessened, and serious effects of sand storms are miti- ted.

The effectiveness of a windbreak is de- ased in proportion to the amount of wind ich sifts through it; therefore the object to present an impenetrable front to wind rms at all times. This may be best ac- nplished by planting trees which grow to good size and retain their branches to the und. About six rows of trees should be nted to make an effective windbreak, but or three rows will be a big step toward ining protection for crops.

The planting of shelterbelts in the Prairie vinces and Ontario has been going on for past thirty years, but at no time have re been so many planted as in the past years. People now realize that a few s in the form of a windbreak add to appearance of a place and so enhance the ıe of property.

t first shelterbelts were planted more personal comfort than for any other rea- It takes much more fuel to warm an osed house than one which is surrounded a windbreak. Shelterbelts also make a ıt difference to the temperature of the ıs. Cattle will not do at all well if turned into the windswept yard in winter. This articularly true of dairy cows which will not give anythtng like the amount of milk they would if the barnyard were protected from the cold and damp winds by a good windbreak. It is not good policy to keep stock in the stables all day. They must have exercise and fresh air, so why not give them some protection while they are out instead of leaving them all huddled up in one corner of the yard? If there is no windbreak the farmer must dig paths through the drifts that always collect about buildings. A farmer who has a good shelterbelt for his buildings once remarked, "I'm two hundred miles farther south than my neighbor across the way."

These same windbreaks in summer, afford shade for the stock they protect in winter. No herd of cattle should be without shade on hot days, particularly in fly-time.

Shelterbelts are a great benefit to orchards particularly when the crop is heavy. They often afford enough protection at the time of a serious windstorm to save a crop and sometimes save the trees as well. In early spring, windbreaks protect the orchard from drying winds at a time when the soil is still quite frozen and so prevents the drying out of new growth that must supply the fruit blossoms.

Many other benefits of shelterbelts could be enumerated such as, aiding in the purification of the water supply, the protection of fall sown crops by an even layer of snow, the value derived from wood products, the aesthetic value, making attractive nesting places for insect-eating birds, its use as a permanent fence, profitable utilization of spots of poor soil, preventative of drifting soil, the prevention of snow drifts along lanes and roads, besides adding value to the farm because these shelterbelts can be used as a source of fuel in case of a winter of shortage.

There is an instance on record of a farmer in Minnesota who during the extremely dry season of 1911, had corn planted in a field protected along the north side of a half-mile shelterbelt strip. This strip was only a rod deep and composed of young trees 25 feet

Fig. 1.—Farm house and buildings protected on two sides with norway spruce windbreaks.

high. That year the crops in other fields of that neighborhood, unless similarly guarded, were worthless. From that side of the protected field which lay next the trees, he gathered sufficient good corn to supply all the seed he needed for 1912. He purchased one extra bushel however. The seed corn gathered from the protected field produced relatively three times the amount produced by the purchased seed. That narrow grove in the one season, more than paid the rent from the land it occupied during the years of its growth. The other benefits then became clear profit.

Farmers are often unwilling to sacrifice the ground necessary for the planting of windbreaks. They figure that they are losing the crop which would ordinarily be growing there if the trees were not planted. Furthermore they argue that the roots spread from the trees and draw the moisture from the soil for some distance, reducing the yield on the strip nearest them. Both of these claims are true, of course, but to offset them there is the value of the posts and fuel which results when the shelter belt is being replaced and the fact that proper cultivation will check the root spread and cut down the loss due to this cause.

Finally the real beneficial effect of the trees will be felt during years of severe drying winds, or bad sand storms, or in such times a good windbreak will often save the crops or minimize the damage done. In other words, windbreaks should be considered crop insurance. The losses caused by sh ing and use of ground are comparable premiums and the fuel and wood obtai when renewal is undertaken is analgous declared dividends. Even in ordinary ye in regions where the rainfall is less th 25 inches, the increase in yield should set the loss caused by the decreased ac age.

Locating Windbreaks

A windbreak should be so located tha will furnish the maximum protection fr the prevailing and most dangerous winds. Ontario the prevailing wind is north-weste therefore the hedge should run north e and south west or along the north and w sides of the field. Since the effect diminis the farther one gets from the trees, it is vious that to protect a crop fully, the wi breaks ought not to be too far apart. S breaks for crop protection should not be m than eighty rods apart. Since most farm lots Ontario are surveyed with an eighty frontage, this allows for a belt of trees each side of the farm, or with a shelterb along the windward side of each lot. N serymen and fruit orchardists sometimes pl a windbreak down the centre of the lot g ing a protective belt every forty rods.

Windbreaks for the protection of fa buildings should not be closer to them th one hundred and fifty feet. If planted c er, deep snow may accumulate around

Fig. 2.—House, garden, orchard and barns entirely unprotected.

rn or barnyard. A dense windbreak too ose to the buildings has the effect of stifng air circulation in summer, while it is not preciably more effective against winter orms than one farther away..

Some farmers prefer to plant their trees the form of a hollow square with the enings to the south or south east. The e of the square depends on the need of ace around the buildings, and the density the hedge depends on the species grown d the side of the prevailing winds.

The effect of a belt twenty-five feet high be felt for about eighty feet in front of and from four to five hundred feet behind The higher the trees become, the more nounced will be the effect on each side of m.

Arrangement and Spacing of Species

The form of windbreak remains for decii with the individual. If it is to consist of row, the species must be of a kind that grow rapidly in its early years, and at times retain its branches to the ground. a general rule more than one row is mmended. If two or more rows are used, trees should be planted alternately with trees of the adjoining rows.

vergreens are especially desirable in ons which have severe winds in winter and ng winds in early spring before the deous trees about the country have come leaf. Between two species of equal value windbreak purposes one should always se the tree which will furnish the best fuel, fenceposts or lumber, so that the products of thinnings may be utilized.

If a single row of cedars is being planted, they should be spaced four or five feet apart. If more than one row is being planted they should be six to eight feet apart in the row and alternate and the rows five to six feet apart. If spruce is being planted they should be six to eight feet apart, and if more than one row is being set out, eight to ten feet apart and alternate, with rows eight to ten feet apart.

Planting

(*a*) *Use of Seedling and Transplant Stocks*—In forest tree planting no preparation of the area is done previous to planting except with hardwoods, but with windbreaks the strip of land on which the trees are to be planted should be broken up the summer before and kept cultivated. This applies to all parts of Canada.

Evergreens for this purpose must be transplanted at least once before being planted permanently. This is done to develop the fibrous root system that is necessary for vigorous growth in the first few years. This means that unless one secures well developed trees from a nursery that specializes in windbreak stock, it is necessary to have a transplant garden for developing the trees for the year or two years previous to permanent planting.

If a resident of Ontario were to secure five hundred evergreens which the Ontario Forestry Branch gives away free each year for shelterbelt purposes, these trees would only

Fig. 3.—The windbreak nursery, showing the size of trees used for this kind of planting.

be two or three years old, or a height of eight to ten inches. They have been transplanted at least once before shipping to the planter, but while they are the most desirable size and age for planting waste forest areas, it is not good policy to plant this size directly for windbreaks. Such trees should not be planted out until they have been in the garden nursery two years. This length of time gives the tree extra height, but the greatest benefit is derived from the stimulus given the small roots by two years of garden cultivation and afterwards the process of transplanting. Should the small trees be directly planted in their permanent location, they occupy a long strip of land for two years without being high enough to give the least protection to the adjoining field. In the windbreak nursery they are in rows which are wide enough for a horse scuffler and about eighteen or twenty inches apart in the row so that here they occupy very little space.

The windbreak nursery should be well cultivated and manured and put in the same condition as for the vegetable garden. When the trees arrive, the roots will be covered with deep moss. They should be kept damp at all times until they are planted in the ground. The trees should be brought from the express office as soon as possible and the box opened in a shaded place out of the wind. The roots should be dipped in water and immediately planted. During summer cultivation either with the scuffler or the hoe, or both, must be done. This keeps the ground in a good growing condition, insu quick root and top growth and keeps do the weeds.

The second spring when the trees are fr two to three feet high they are ready to transplanted permanently to the ground t was prepared for them the previous summ Windbreak rows should be kept straight cause this is formal planting but care n not be taken about straightness of rows wl planting shelter belts.

(b) *Cultivation*—On the poorer soils where the trees may be subject to long p iods between rains, cultivation is essen to rapid growth. The rows should never allowed to become a harbor for noxi weeds, as weeds and trees cannot thrive w on the same area. Rows should be cultiv ed after heavy rains, especially in clay so but cultivation should not be continued i the late summer and early fall as this sti lates new growth which will be killed b by the first frosts.

The importance of cultivation is often realized by the owner but this is a p upon which too much emphasis cannot placed if rapid growth is desired. Cult tion takes the place of the leaf mulch fo in the forests. It conserves the soil m ture and is especially recommended du dry spells of weather. The fine toothed scu is the best cultivator to be used as it ca adjusted to suit the rows. Considerable should be taken that the trees are not b ed in the process of cultivation.

Fig. 4.—A double row of norway spruce on each side of the driveway, sheltering fields on one side and an orchard on the other.

(c) *Thinnings*—Shelterbelts may become owded after being planted for fifteen years d some trees will lose out in the compe- ion for light, while others will become ppressed by their more dominant stronger ighbors. These dead and suppressed trees ould be removed from time to time as ey are only using space needed by the rvivors. At all times diseased trees, such those affected with fungus and those suf- ing from insect attacks, should be remov- and burned as these serve as centres of ection. It is just as necessary to be watch- for tree diseases in the shelterbelt as it among the crops or the live-stock.

(d) *Renewal of Shelterbelts*—As a shelter- t begins to reach maturity, it often begins lose its power to check the wind due to the ng of lower branches and the opening up the stand as the trees die in the race for ninance either from suppression, insects, gus, fire or windstorms. Some provision st be made for renewal. When this be- nes necessary it should be done by a ser- of cuttings, no one of which should re- ve more than 25% of the stand, the re- inder being left as a protection to the new trees until they reach an effective size. Many schemes for renewing shelterbelts have been put forward, some of which have not been the success that was claimed for them. The most successful method is to remove the row of trees farthest from the prevailing wind and then at intervals of three or four years cut out the next row to windward. This insures protection for the crops until the last row to windward has been cut, and by that time the first row planted may have reached considerable height. But whatever system of renewal is adapted do not remove all the trees at once.

Occasionally underplanting may be needed. This means, as the name implies, the planting of small trees under and between the larger ones. This often becomes necessary where trees have reached such a height that the lower limbs are dying for want of light and the stand is opening up letting the wind through. These openings must be filled in with some species that will stand shading. White beech is a species that would do very well along with the conifers as it is very resistant to shade.

Some Russian Impressions.

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In the development of Soviet Russia the amount of attention paid to scientific research has been a very interesting feature to many observers. The research in agriculture and the biological sciences generally, has a special importance for Canadian workers in these fields, in view of the similarity of many of the problems to be faced in large areas of Russia and in Canada.

When Dr. Georg Karpetchenko and other members of the Bureau of Applied Botany and Plant Breeding, Leningrad, very kindly offered to obtain visas and make other necessary arrangements for us in Russia, my wife and I very gladly accepted their offer and in September last spent three weeks there.

In view of the many conflicting reports of present-day conditions in Soviet Russia, it will perhaps be of interest if some impressions of the general conditions are given in conjunction with an account of the work seen at different scientific institutes which were visited. Needless to say, these remarks are mere first impressions, as no close study could be made in such a vast country as Russia, in such a short space of time.

We entered Russia through Finland, after three weeks spent in visiting various agricultural and other biological institutes in Denmark and Sweden.

After the extreme order and cleanliness of Scandinavia, the disorder and tumble-down condition of Leningrad made a very bad first impression. But it is only fair to say at once that this impression was more or less dispelled in other parts of Russia. Leningrad, from being the first city of Russia, has lost its place of importance as the seat of government as well as most of its trade. Its depressing condition is not, therefore, surprising.

In Leningrad, at Morskaja 44, in a building which was formerly one of the Government Ministries (the Bureau of Agriculture, I believe), is situated the Bureau of Applied Botany and Plant Breeding. This Bureau, of which Professor N. I. Vavilov is the Director, has a controlling influence over most of tl applied plant research carried on througho the whole territory of the U.S.S.R. The Bu eau has assembled at Leningrad a tremendo collection of cultivated plants and seeds. Tl seed collection is stated to contain ov 12,000 samples of wheat, about 6,000 of ba ley, 4,000 of oats, 1,500 of maize, 1,000 flax, 2,000 of peas, 1,500 of beans, and son 5,000 samples of various vegetable seed These have been obtained from practically a over the world, though, naturally, Russia types constitute the majority. Many ha been obtained from workers in other cou tries, and so are duplicated elsewhere, b a large number have been collected in out-o the-way parts of the world, by special pa ties sent out by the Bureau, and so are uniq and rare. In wheat and oats at least, one safe in saying that the collection is witho equal anywhere.

Three plant surveying and collection parti were sent out during 1926, and, at the tim of our visit in September, large quantiti of seeds and plants were arriving at th Bureau. Professor Vavilov was surveyin various countries around the Mediterranea Sea; Dr. Bwokassov was leading an exped tion in South America; Dr. Kusnezov w directing one in Trans-Caucasia. In previou years, expeditions have been sent to Mongol under Dr. V. E. Pissarev; to the White Se area and the Caucasus and Turkestan und Dr. Kusnezov; to Turkestan and Afghanista under Professor Vavilov; and to Turkish A menia under Dr. P. M. Shukovski.

The Introductions Branch of the Burea is directed by Professor Kol, and it was h who demonstrated the work of the Leningra institute to us. Professor Kol spent som years in America just before the Russia Revolution, and is especially interested in th agriculture of Canada and the Northern Uni ed States.

The plant collection thus assembled is o tremendous interest to systematists and othe

*1851 Exhibition Science Research Scholar.

interested in the evolution of the various groups of cultivated plants, and it is also of very great value to plant breeders and other practical agriculturists. Detailed maps are being prepared as collections of plants and seeds are received and surveys completed, and correlations are being established between the types of vegetation and climate and other environmental conditions. Especially intensive maps are being prepared of the entire area of the Soviet Union. When this work is completed it will be possible to form fairly accurate off-hand judgments regarding the suitability of newly introduced samples of seeds for the various districts of the Union. Much needless experimentation with varieties unsuitable for the particular conditions of any given locality will thus be avoided.

Seeds of some of the most important varieties of different crops have been sent to as many as 100 different experiment stations throughout Russia, so that their behaviour under all sorts of different conditions could be thoroughly studied. Cotton, for instance, has been planted within the Arctic Circle, not of course with any idea of its being of any value there, but merely to see how it behaves under such extreme conditions. With each sample of seed is sent a standard form for the recording of all data. These forms are returned to Leningrad at the end of the season, and the complete data covering the origin and behaviour under varying condition is then bound into a single volume for each variety. All samples of seed in the collection are sown every third year to ensure the retention of a viable supply of each.

The work of the Bureau is divided according to the types of the various crops studied, and each division is directed by a specialist in that line.

Cytological studies in pure and applied botany are carried on in the Leningrad institution by Professor J. Levitsky, Dr. Helen Emme, and other workers.

A visit to the Leningrad Botanical Gardens furnished a big surprise. This Garden, founded by Peter the Great in 1713, was famous before the Great War for its collection of rare and exotic plants, and especially for the completeness of its Northern Asiatic collection which was the largest and best in the world. But, after the Great War, two revolutions, a civil war and a famine, one hardly expected to find much of this fine collection remaining. Judge our surprise then, to find a magnificent collection still in a flourishing condition. "How ever were these plants and trees kept alive," we asked as we entered one large tropical house, for we knew that during the famine there had been practically no fuel in Leningrad. And we were told that the Director, Professor Issachenko, with a small faithful staff had somehow managed to keep the green house fires going, though their own rooms were for a long time entirely without heat and they had barely sufficient food to maintain life.

Today the Botanic Garden has a staff of 100 scientists and 220 clerks, manual workers, etc. Its original large collection of tropical plants has been enriched by numerous specimens taken from royal and private greenhouses. Many of its greenhouses are very old, a number dating back to 1823, and need to be rebuilt, but, considering the circumstances, one is surprised to find most of them in a fairly efficient state of repair. The enormous collections of hardy and semi-hardy plants are very efficiently grouped in the somewhat limited available area. Owing to the severe winters experienced at Leningrad, representative specimens of most species have to be moved indoors for the winter. This naturally involves a tremendous amount of labour. The Head Keeper of the Garden is Professor Iljinsky.

The library of the Botanical Gardens contains about 45,000 volumes, some of which are very rare and old. A reference to the number of works received and published in different years gives one some idea of the conditions passed through and the present degree of recovery. For instance, the number of works received was 409 in 1909, 398 in 1914, 23 in 1920, 187 in 1923, and about 300 in 1925. In 1915, 218 works were published, in 1919 only 7, in 1922 the number had risen to 81, and in 1926 about 200 contributions were being published from the various laboratories and departments of the Botanic Garden.

The Herbarium, located in a fine spacious building, externally somewhat in need of repair, contains over 1,000,000 herbacious specimens. It has also a large number of very fine paintings of flowers, and a good collection of flowers dried by a recently improved special process.

Apart from the work in systematics, the Botanical Garden has also a number of other research laboratories, encluding an Ecological Laboratory, a Physiological Laboratory, and a Laboratory for the Investigation of the Medicinal Properties of Plants. There is also an extensive museum fitted up especially for teaching purposes.

During our stay in Leningrad we were allotted a room in the House of Scientists. In Russia the term "scientist" is used in its broadest sense to include workers in all fields of organized knowledge, and the provision by the government of a House of Scientists in each city for the accommodation of scientists visiting, or engaged in temporary work there, is an indication of the importance attached to the progress of knowledge. The House of Scientists in Leningrad occupies what was formerly the palace of one of the Grand Dukes. It is a splendid building near the former Winter Palace. At the time of our visit it was very crowded, though there were no other foreign visitors, so we were installed in the library. All around this very large room were glass-fronted book cases filled with works of all description in Russian, English, French and German. But every case was sealed with a large, red mass of sealing wax bearing the impress of the Soviet emblems . . . the hammer and sickle. We were told that all such private property was similarly sealed immediately after the revolution and that it was gradually being removed to public museums and libraries. From the windows of the library we had a magnificent view across the broad Neva, with the slender golden spire of the once-dreaded Peter-Paul fortress just opposite.

Boiling water for making tea is supplied free at the House of Scientists, and as far as we could judge, most Russian "scientists" live on tea with bread or cakes at various times of the day, with one good meal in the early afternoon..

Near Leningrad, at Detskoe Sselo (Children's Village), sa called on account of the large number of homes for homeless children now established there, is situated the Central Research Station for Genetics and Plant Breeding, Director Dr. V. E. Pissarev. This institution (and the children's homes) occupy villas and palaces which were previously the summer homes of the Tsar and his court, the former name of the village being Tsarskoe Selo. The work of this station is subdivid into various sections, including a Division Agricultural Genetics, one of field expe mentation, another of immunity studies, a a biochemical section which conducts mi ing and baking tests of cereals, and vario tests of flax and other crops. The milli and baking test laboratory here, is the fi and only one so far established in Russi though another is now being fitted up at t Saratov station. Complete equipment for t testing of fibre flax has just recently be installed at Detskoe Sselo.

Of the various phases of his work in pla breeding demonstrated by Dr. Passariv, t most striking was that on rye. Commenci with a geographical collection of rye co prising 800 varieties, over 12,000 individu plants have been selfed and propagate Striking differences in the degree of sel fertility have been discovered in varieti from different regions. Some varieties gi a very large number of wild and other abe rant types when selfed. The percentage such aberrant types shows a clear negati correlation with the degree of self-fertilit High yielding varieties which are highly sel fertile are now being multiplied.

The Division of Agricultural Genetics Detskoe Sselo is directed by Dr. George Ka petchenko. Some very interesting work genetics, corrolated with cytology, is bei carried out in this Division. The be known of this work is perhaps that on a ca bage-radish hybrid. Dr. Karpetchenko h published some of his most interesting fin ings in this hybrid, and during his thre months visit to England in the Spring 1926, I had the pleasure of seeing many his cytological preparations. These includ some which show one of the modes of orig of more or less fertile polyploid plants fro the practically sterile progeny of a cross b tween widely different species. At Detsk Sselo, I saw many of these polyploid plan growing, and as they were in the fruiti stage it was very interesting to compare t degree of fertility in each plant with its chr mosome number and behaviour, which D Karpetchenko and his assistants have dete mined. The limitations of cytological stu ies, as well as their value is well shown this work, as some tetraploid plants wi good reduction divisions turn out to be almo completely sterile. Other tetraploids whi

are fertile cross readily with the radish parent, but not with cabbage. As might be expected, there is tremendous variation in the F_3 of the cabbage-radish cross.

The relative nature of Mendelian dominance is nicely illustrated in a number of crosses in the general Raphanus and Hordeum made by Dr. Karpetchenko, in which characters which are dominant in one cross are found to be recessive in others.

All sections of this Central Research Station are well supplied with equipment, and all the trained workers seem to have plenty of semi-skilled helpers. One gets a general impression of an efficiently equipped research station receiving adequate financial support.

At Peterhof, where Peter the Great had his summer palace, there is a very interesting Institute of Natural Science. This was established six years ago on the initiative of Professor V. Dogeil, now Director of the Institute, and other professors of the University of Leningrad who desired a quiet place near the city where they "could study nature in nature." The government has given them for this purpose a very fine estate on the shores of the Gulf of Finland, which was formerly owned by the Grand Duke von Leuchtinberg. The buildings have been magnificent, but are scarcely the most convenient for scientific research and at present are in very bad repair. The heating plant has not yet been repaired since the revolution and there is no electric power. There are eight departments in this institute, two of zoology, two of psysiology, one botany, one genetics, one ecology, and one of hydrobiology. The staff comprises eight chiefs and seventeen assistants. In addition there are eighteen "aspirants," or graduate students who receive a government stipend of 80 roubles ($40.00) per month and free living quarters. These aspirants are, in many ways, better off financially than the staff, whose salaries mostly range from 150-250 roubles ($75-$125) per month, out of which they must provide and maintain their own homes and pay taxes. Many of them have to get extra part-time work in order to make ends meet. Scientists come from all over Russia to work at this institute, and there are generally from 130-140 workers there each summer.

The work of most agricultural interest at Peterhof is that of Professor Philiptchenko on inheritance in the hexaploid or bread wheats, especially in relation to quantitative characters. It is impossible to describe this work briefly. Much of it has been published in the *Zeitschrift für induktive Abstammungs-und Vererbungslehre*, and other German journals. Dr. T. Leipin and others are carrying on extensive researches with the tetraploid wheats such as T.durum.

The ecological work is conducted on very extensive lines and has yielded some very interesting results. On representative quadrimeters of land the entire plant and animal population has been determined. The latter has been found to be composed on the average of 95% non-parasitic "ticks." Different kinds of berries have been found to have characteristically different kinds and numbers of animal organisms living on them.

A high-explosive shell which accidentally landed in the grounds of the estate during the naval mutiny at the nearby island-fortress of Kronstadt, has furnished an artificial pool in which the ecologists have made annual studies of the development and changes of the incoming flora and fauna.

The geneticists and cytologists who are working on *Drosophila* have obtained many mutations similar to those found by the Morgan school, and also some interesting new ones. They are working with a number of different species.

It is impossible to mention all the work of the institute which covers many fields of research. The general impression I carried away was that a great deal of splendid work is being accomplished, but that it is all sadly hampered by lack of funds, shortage of equipment and lack of current and recent scientific publications. Workers in other countries could do much to help to relieve the latter difficulty by sending separates of their publications to the Director, Professor V. Dogiel, University of Leningrad, and such help would, I am sure, be greatly appreciated.

The oldest agricultural high school in Russia is at Petrovsko-Rasumovskoye, a suburb of Moscow. Founded in 1872, this academy was soon closed down owing to the revolutionary activities of its students. Later it was reopened as a high school for the sons of rich landowners only. After the October (Bolshevik) revolution of 1917 it was reorganized and renamed the "Timiryasev Academy" after the other revolutionary, K. A.

Timiryasev who was a professor there. The Academy has now a high school, a Workers' faculty, a dairying institute, an agricultural experimental and plant breeding station, and a forestry station.

The first plant-breeding work in Russia was begun at this Academy in 1902 by Dr. Rudinsky. In 1922 Dr. Shegalov succeeded to the Dictatorship. Many good varieties of winter-wheat, oats, flax, peas, potatoes, grasses, and of different vegatables have been produced. Of special interest to me was the work in oats which Dr. Shegalov and his assistant Miss Mitrofanowa kindly demonstrated in detail. The oats hybrids which have been made and investigated include *A.fatua x A.sativa* (many varieties), *A.sterilis x A.byzantina, A.byzantina x A.sativa, A.byzantina x A.fatua, A.sterilis x A.fatua, A. barbata x A. sativa, A. brevis x A. nuda biaristata* and *A.nuda inermis x A.fatua.* Many exceedingly interesting facts have emerged from these studies of hybrids. It is unfortunate that very little has been published about them except some short accounts in Russian; perhaps Dr. Shegalov will publish more complete results soon.

A strain of oats isolated by Dr. Shegalov, which originated from a single plant in 1911, regularly segregates an extraordinary giant type. These giant oats are very tall, have leaves and stems about twice as wide as the normal type, and are very late and almost completely sterile. A few seeds are obtained from plants kept in the greenhouse. Dr. Shegalova has published in *Zeitschrift für induktiv Abstammungs-und Vererbungslehre* 29:207-208;1922, an abstract of a Russian paper on this strain. The work with it is being carried on, and the possibility of obtaining fertile giant plants is still engaging attention. According to the researches of the late Dr. Nikolaewa, the sterile giants have the normal number of chromosomes.

My visit to the Timiryasev Academy was unfortunately too late in the season for me to see the field work in plant breeding and variety testing, which is evidently very extensive. The different departments of the Academy are quartered in commodious buildings, some of them quite new, and all appear to be well equipped and well supported financially.

An account of the work of the Moscow Institute of Experimental Biology, by the Director, Professor N. K. Koltzoff, appeared some time ago in *Science* (1) so no attempt will be made to describe it in detail here. The extensive nature of the research being carried on at this Institute is one of its most striking features; almost all phases of biological research seem to be represented. The institute is housed in a large building on a fine site overlooking the Moscow river in the eastern section of Moscow. The extremely crowded condition of Moscow today is reflected in the cramped quarters in which workers in this institute live. Different workers kindly demonstrated the progress in a number of the research projects described by Professor Koltzoff in his article. Madame Koltzoff has now a very interesting research in progress on the inheritance of psychological characters in rats. The lack of space available for this experiment would in itself be sufficient to deter any less enthusiastic worker.

The Timiryasev Institute (quite distinct from the Timiyasev Academy) is situated in the Southern part of Moscow. The Director of this Institute, Professor Navashin, kindly placed one of his rooms at our disposal, so this became our headquarters during most of our time in Moscow. The institute occupies an old but once magnificent house, formerly the home of a rich merchant. The work in cytology and genetics carried on here by Professor Navashin and his son Dr. M. Navashin, is too well known to need description here. It was a great privilege to see so many of their beautiful cytological preparations, and to discuss different cytological and genetical problems. No clearer demonstration of the double fertilization of egg cell and endosperm fusion-nucleus could be imagined than that seen in one preparation demonstrated by Professor Navashin. Of Dr. Navashin's many *Crepis* preparations seen, perhaps the most interesting were those showing the inheritance of specific chromosomes. The parent plant of this particular experiment had a pair of unequal homologous chromosomes, the one bearing a large "trabant," and the other a small one. The progeny have either two chromosomes with small trabants or a pair with one of each size as in the parent, or two with large trabants, and these combinations, occur in the 1:2:1 Mendelian ratio.

(1) Science 59:497-502. 1924.

Comparisons of the conditions in the differ- visited, led to the conclusion that the Soviet ent institutes of pure and applied biology Government supports applied research very much more than it supports pure science. At the same time, the facilities for pure science have also been increased since the revolution. The definition of applied research is also extremely broad, as is indicated by some of the work in the Bureau of Applied Botany such as the studies on the original of cultivated plants, and some of the numerous cytologial investigations. The good results already achieved through this broad interpretation are said to be likely to lead to a still further broadening of the scope of applied research, as soon as financial conditions permit.

The "Bolshevik" Government loses no opportunity of spreading propaganda favoring its particular political and economic creeds, and it was a rather amusing feature to find that in these scientific institutes we visited, as in all public puildings, there was by order of the government a "Lenin Corner" . . . . a small room hung in red, with a bust or portrait of Lenin draped in red, and tables covered with "red" literature.

In this short visit covering a comparatively small area of the vast territory of the U.S.S.R., it was impossible to form an adequate opinion of the probable rate of agricultural expansion . . . . . a question which is of paramount importance to the Soviet Government, and of particular interest to Canadian agriculturists, in the matter of competition in European markets. It is commonly believed in Russia and elsewhere that the present regime will stand or fall according to its success in handling the agricultural problem. Perhaps because of this, it is very difficult to get reliable figures and opinions of the agricultural situation. My first impression on seeing the vast areas of apparently fertile land lying idle even in the neighborhood of the large cities, and on finding the scientific side of agriculture being developed with such enthusiasm and energy, was that in a very few years Russia would be exporting enormous quantities of grain and other agricultural produce. If government influence can accomplish this, it will certainly come to pass very soon, as the authorities are doing everything they can to speed production by financing agricultural research, importing agricultural machinery, and encouraging the peasants in every way. But there are many factors to be taken into consideration, not the least of which is the psychology of the peasant, and so development may not be nearly as rapid as one accustomed to American rates of progress would imagine from seeing the opportunities for rapid expansion which exist in Russia today.

Since my return to London I have had the advantage of many discussions with Professor R. R. Gates, who spent some six weeks in Russia last summer, and in particular I am indebted to him for a critical reading of this article.

Training Unadjusted Boys as Farmers.

E. P. BRADT

Boys' Training School, Bowmanville, Ont.

In a previous article in *Scientific Agriculture* a brief outline was given of the proposed agricultural course at the Boys' Training School, Bowmanville, Ont. In as much as the School represents something entirely new and different to any previously established in Canada, the plans we are working out, and the ideas we are putting into practice, may be of interest to agricultural workers in other fields.

There are at present seventy-two boys in residence. Eventually, we expect to have three hundred. It should be kept in mind that practically all of them are city bred and raised. A few have spent short vacations on the farms of relatives outside the city, but their farming experience can be said to be nil. The boys range in age from ten to sixteen years, and are thus at what is usually termed the impressionable age. We are endeavoring to make useful citizens of these boys, and it is felt that those with a natural bent for the farm, can be turned into such, by giving them a working knowledge of farm operations and thus fitting them to go out and be satisfactory help to farmers in the Province.

After all, if it is gone about in the right way, it is not a very difficult task to develop a liking for the farm in the heart of a boy. There seems to be an inherent love of the land deep rooted in the heart of the human race. In this new country, I suppose, that can partly be attributed to the fact that the majority of even the city bred men are only a generation or two removed from the land. This being true, it can easily be imagined that the boys' school here, surrounded by three hundred acres of fertile soil, where all classes of live-stock will be kept, will awaken in many a boy a desire to become identified with farming as a life work. In fact, such evidence is already by no means lacking.

It is a fact, nevertheless, that there is such a thing as a boy having a flair or natural bent for certain work. It would be foolish to try to make farmers out of all the boys. Departments have been established by the Superintendent, Dr. G. E. Beaman, in Metal Working, Motor Mechanics, and Wood Working, in addition to the Agricultural Department. Thus the boys when they enter the School go through a sampling process. They have the opportunity, and in

Boys hoeing their garden

fact it is compulsory, to spend a certain amount of time in each department. The regular school curriculum is so arranged as to make this necessary. This gives the boys a chance to find themselves, as it were, and at the same time gives each instructor an opportunity to size them up and help get them adjusted and fitted into their proper niche.

The younger boys, from ten to thirteen, of course, spend practically all of their time in academic school work. As soon as a boy reaches the age of thirteen and is in Grade 4 in his academic subjects, he is eligible to apply for special vocational training of a definite nature.

The Apprentice System has been adopted as being the most suitable for the boys at this School. For example, those who choose farming, become apprenticed to the farm department and are required to learn the practical side of farming by helping with the general work around the place. For this work they are allowed pay based on a sliding scale of five to ten cents per hour, depending on the extent of progress they have made in their training. The following is a brief outline of the course of training and the work performed in the various grades of the agricultural apprentice group. This covers their outside activities only. In addition, they are given a regular course in Agriculture in the class-room.

COURSE OF TRAINING FOR APPRENTICE AGRICULTURISTS

Minimum Eligible Age—13 Years.

Two Year Course

FIRST YEAR—General Farm and Barn Work.

SECOND YEAR—Specialization in some one branch, such as Poultry, Dairying or Gardening, Apprentices being required to pass through three grades, A, B and C, promotion taking place from one to the other as Apprentices qualify to do so.

Schedule for Various Grades

GRADE C. (Beginner's Grade).

1. Cleaning Stables and Pens.
2. Grooming Cattle and Horses.
3. Learning to Milk.
4. Hoeing and Weeding.
5. Practical Farm and Barn work of a routine nature.

GRADE B.

1. Hitching and Driving Horses.
2. Ploughing and Cultivating Land.
3. Preparing Feed for Live Stock and Poultry.
4. Some Feeding of Certain Kinds of Stock.
5. Experimental Plot Work.
6. Planting Garden Seeds.

GRADE A. (Specialization Grade)

Most boys will have developed preferences for certain branches of Agriculture by the time they have reached this grade. In this

Training Calves for the fall fair

grade they will devote their full time to specialization in the particular branch in which they are interested. Any who do not show such preferences will be fitted for a position on a general farm.

Poultry

1. Hatching and Rearing of Chickens.
2. Operation of Incubators and Brooders.
3. Feeding and Care of Laying Hens.
4. Crate Fattening of Poultry.
5. Killing and Dressing for Market.
6. Poultry Culling.

Dairying

1. Feeding of Dairy Cattle.
2. Care of Milk and Cream.
3. Cream and Milk Testing.
4. Butter Making.

Gardening and Fruit Growing

1. Operation of Hot Beds and Cold Frames.
2. Planting and Cultivation of Vegetables.
3. Preparation of Vegetables for Market.
4. Strawberry, Raspberry and Asparagus Culture.
5. Apple Culture and Packing.

The above outline will give some idea of how the work is planned to give these boys sufficient practical experience in farming, so that they can go out and be useful help on either a specialized or general farm.

Some of the boys at the School have already spent several months at farm work here and can milk, hitch and drive horses, care for poultry, feed live stock, and do general work around the farm and barn in a very creditable manner. This is encouraging to those of us in charge, and gives us confidence that two years' training will fit these boys for a useful place in life. Thus the reclaiming of unadjusted boyhood goes on day after day at the School. Who can, or dare, try to figure in dollars and cents what some of these lives may mean to the country in later years? They are at least being given a chance that otherwise they never would have had. After that it is up to them. We, who are working with them, have every confidence that many will go out and make good Canadian citizens.

A Suggested Basis of Payment for City Milk.

E. L. EATON

Agricultural Representative, Bridgewater, N.S.

Recent reports of the annual meeting of the British Columbia Holstein Breeders' Association indicate strong opposition to the payment for milk on a butter fat basis. The contention is that the skim milk has some value as well. Where the milk is standardized before delivery to consumers it is the practice to mix that from the Holstein and Jersey herds, putting the entire output on approximately a 3.5% basis. Transportation is charged on the weight without regard to butter fat test and the claim is made that this gives an unfair advantage to the man who sells high testing milk. In support of this contention it is pointed out that if carried to its logical conclusion everyone would be separating their milk and sending only the cream! That the skim milk has a value none will question and a more equitable system of payment seems imperative.

Nor is the dissatisfaction confined to the province of British Columbia. Various proposals have been made from time to time and probably none is completely free from weakness. However, the following is suggested as being workable and at least some improvement on the payment for butterfat alone. It assumes an average price of 40c per pound butterfat and $1.00 per hundredweight for skim milk. It is seldom, probably, that the price will be less than this at city points.

In illustration of the application of the method two examples are cited.

EXAMPLE 1. Shipment of 100 lbs. of 3.6% milk.

100 lbs. @ 3.6% equals 3.6 lbs. fat @ 40c	$1.44
96.4 lbs. skim milk @ $1.00	.96
Total payment	2.40
Per quart	.06

EXAMPLE 2. Shipment of 100 lbs. 4.6% milk.

100 lbs. @ 4.6% equals 4.6 lbs. fat @ 40c	$1.84
95.4 lbs. skim milk @ $1.00	.95
Total payment	2.79
Per Quart (nearly)	.07

Should the net returns exceed this amount the balance may be rebated in proportion to the original cheque. Transportation and other expenses may of course be deducted from the payment in the usual way. In areas where competition reduces the price below the standard cited a reduction may be made proportionately in the price of the butterfat and skim milk.

Thanks to Researchers.

H. G. L. STRANGE

Fenn, Alberta.

"This very Alberta has been at least ten distinct times beneath the seas during the course of untold ages past. This has been one of nature's ways of storing up treasures in the earth so as to make the world habitable for man. But nature has contrived, by locking these treasures in her secret vaults, that man must put forth his most intelligent efforts in order to win them for his comfort. You agronomists are the men upon whom this country depends to find the right keys to unlock the secret doors to these vaults of nature and so make their treasures available for the use of man."

So, in substance, said one of the most brilliant and able thinkers of this country at a meeting of the Western Canadian Society of Agronomy held recently at the University of Alberta. For three days I sat as a modest spectator, absolutely enthralled with the wonderful picture of agricultural research and experimental work as unfolded by the addresses and discussions of members of this society. I heard explained with the aid of charts, diagrams, and photographs, the many ways in which the scientific worker in agriculture is attempting to learn some of the truths and secrets of nature in order that the happiness and prosperity of the farmer, and indeed of all mankind, may be increased.

Some of the addresses showed that several more of nature's mysteries are about to be revealed: such, for instance, as a very elaborate research investigation, now almost completed by the University of Alberta, as to the exact reason why some plants are able to endure severe drouths whilst others succumb under the same conditions; or, as this piece of research is technically entitled; "The nature of drought hardiness in plants."

Up to the present it has taken years of patient field experimentation to determine whether a certain plant is drouth-hardy or not. Now this research work has revealed a method by which a plant can be subjected to certain laboratory tests, and a very accurate estimate can be made in a few hours as to whether the plant is likely to be able to withstand a bad drouth or not.

Much the same success has been attained in the investigation of the nature of winter hardiness of plants, or, as it is commonly expressed, the winter killing of plants. It is difficult to estimate the years of elaborate and expensive field tests that these two pieces of research work alone have rendered unnecessary.

Another striking address showed clearly that the scientist is gradually obtaining a clearer perception of the marvellous processes being undergone in the soil by which the countless millions of different varieties of bacteria which inhabit the soil transform minerals and a hundred and one other elements into foods that the plants are able to assimilate and so produce crops.

The Research Council of Canada is sponsoring an elaborate series of researches into every factor dealing with the wheat plant, from the first seed up to the final loaf of bread. This has proceeded to the extent that some of the highly complicated factors which go to the make-up of a palatable and digestible loaf of bread are beginning to be exactly known and appreciated.

Then, to keep the imagination of these intelligent and zealous scientists within bounds —to keep their feet on the ground, so to speak — comes the professional mathematician, lecturing them in a highly technical manner on the subject of the estimate of the probable error, or, as our mathematician himself puts it: "The application of biometry to agronomic experiments." These mathematics are for the purpose of eliminating, as far as possible, from the final results of the agricultural worker any errors due to differences of conditions that are not controllable by the experimenter.

The above are but a few of the interesting and valuable facts brought forth at the meeting of this society. But one thing can be truly said: that all the researches and investigations and discussions of these people

will continue in the future, as in the past, to lead surely and certainly to the practical effect of producing larger crops per acre and of higher quality and so eventually to a greater agricultural prosperity in Canada.

The men who gathered as members of this society are engaged in scientific agricultural research and experimental work, some from the Dominion experimental farms, some from provincial governments, others from various universities, and others, again, from agricultural colleges. But no matter from which branch of agriculture they happened to come, these men, it is easily apparent, were all possessed of a zeal to find out the truth and a way to make the truth of service to the Canadian farmer.

As I sat and listened to the intense fervor and enthusiasm with which these scientists discussed and exchanged notes about these important matters, I could not but think how very much I and my fellow farmers and indeed perhaps every person today making a living in Canada, owe to these quiet, modest, unassuming men, who are devoting their lives to agricultural service. And I thought, just what is it that makes them do this? Certainly not the monetary reward. I felt ashamed , rather, when I discovered the very modest, almost parsimonious, salaries they receive. I have come to the conclusion, though it may be difficult to believe in this commercial age of strikes and unions and monopolies, with the continual grumbling against conditions, that these men are working because they are filled with the earnest desire to perform a service to science and to Canada.

Out of it all, what will be the reward of these scientists? What do they expect? Certainly even brilliant successes in their fields of endeavor will not bring them unusual profits, as might be the case in commerce or industry, and time will not automatically raise the value of their land, as is the case with the farmer. But this they will get, perhaps it is all they will get, certainly it is all they themselves expect—a glow of quiet joy and satisfaction that they have been the means of adding to the happiness, contentment, and prosperity not only of every farmer but also of every individual who makes his living, even in the most indirect fashion, from agriculture in Canada.

With the exception of an odd, rare individual, their names are unknown and their praises unsung. This praise or fame they are not looking for. But one thing can and should be accorded them freely and generously. It is that they may be allowed the funds necessary to provide them with the equipment and apparatus and time necessary to perform their so valuable services to this country.

I know that every farmer in Canada, if they could have seen and heard all that I saw and heard, would join me in a salute of appreciation and respect to the Canadian workers in scientific agricultural research.

Annual Meeting of Western Society of Animal Production.

The first annual meeting of the Western Canada Society of Animal Production was held at the University of Alberta, Edmonton, Dec. 30 and 31, 1926. It was a success from every standpoint. The work of the Society for the year had been well planned with definite objectives in view and had been well carried out by the different committees, appointed at the organization meeting a year previous, as follows—Executive Committee, dealing with the summarizing of all experimental data in connection with live stock at the different Western Canada Institutions; Special Committee, dealing with the question of soft pork; Committee on Methods of Investigation, and a Committee on Methods of Instruction.

The progress report of the Executive Committee by Vice-President Professor A. M. Shaw was the first report presented, consisting of a summary of all data reported to the committee by the different Institutions respecting swine experiments. The data in connection with other classes of stock had also been received by the committee but owing to its immense volume and the limited time at the disposal of the committee it was found impossible to summarize any of these data. The swine progress report brought out a good deal of discussion and was finally adopted and referred back to the committee for completion during the year. The need for improvement in experimental technique and the advisability of adopting a more or less standard form for reports were brought out in the discussion.

Prof. J. M. Brown, Chairman of the Special Committee, presented a paper on the vork of his committee during the year, Co-perative experiments had been conducted by he different Federal and Provincial Institu-ions and a careful survey had been made of ll data on record in connection with the uestion. In summing up the findings Profes-or Brown stated,—"The chief influencing actors, according to present knowledge, may e summed up according to their importance n the following order: 1, Underfinish; 2, Im-aturity; 3, Lack of thriftiness, caused by a) unbalanced rations, (b) insufficient feed, c) improper management; 4, Kind of feed soy beans, peanuts); 5, Individuality of igs; 6, Exposure to cold and dampness. The uestion of soft pork will be further consid-ed during the coming year and an endeavor ill be made to enlist the co-operation of e packers in carrying on the work.

Dean W. J. Rutherford, Chairman of the ommittee on Methods of Instruction was nfortunately unable to be present and con-quently his report was read by Prof. R. D. nclair a member of the committee. The port dealt with the whole field of instruction animal husbandry under the following div-ons: (a) Degree (Professionals); (b) As-ciates (Embryo farmers); (c) Adults (far-ers); (d) Adolescents (Boys and Girls). e first division was dealt with very fully, ginning with a historical review of instruc-n in animal husbandry and leading up to e present day methods. The subjects that ould be included in the Degree course in imal husbandry were recommended as fol-ws:—First year, field husbandry, animal sbandry, english, mathematics, chemistry; cond year, dairy, poultry, english, physics, emistry, genetics, organic chemistry, zool-y (anatomy and physiology); Third year, imal husbandry, crops (forage and fodder), rasitology, horticulture, chemistry (biologi-), economics,—Electives, education, lang-ge, science and history; Fourth year, ani-l husbandry, animal husbandry, animal sbandry,, vetrinary science, — Electives, rketing, farm management, soils and crops. was also recommended that whenever pos-le, education be one of the subjects re-red in the fourth year for all students maj-ng in animal husbandry.

W. H. Fairfield, Chairman of the Commit-on Methods of Investigation, presented the ort of his committee under three main dings, viz., 1, Increasing the number of mals in the group reduces the experimental error; 2, The advantages of individual weights over group weights; 3, The value of chemical analysis of feeds used in feeding experiments. Full discussion of the different points followed the presentation of the report and while no definite conclusions were reached on any point yet the importance of proper experimental methods was brought out very forcibly.

The matter of completing the summaries of the experimental data respecting the different classes of live stock was fully discussed and as already stated the swine work was again alloted to the committee which had previously dealt with it. The live stock committees are as follows:—Swine, V. Matthews (chairman), A. M. Shaw, J. P. Sackville; Horses, H. B. Sommerfeld, (chairman), W. H. Gibson, R. M. Hopper; Dairy Cattle, G. W. Wood (chairman), W. A. Munro; Beef Cattle, R. D. Sinclair (chairman), A. Newman, W. M. Cockburn; Sheep, J. E. Bowstead (chairman), E. Van Nice, H. E. Wilson.

The Special Committee, J. M. Brown (chairman) and L. M. Winters, will arrange co-operative experiments at the different institutions to ascertain the effect of self-feeding in the production of select hogs. The question of soft pork will also receive further attention.

The standing committees are as follows:

Committee on Methods of Investigation—L. M. Winters (chairman), M. J. Tinline, H. B. Sommerfeld, V. Matthews, W. H. Fairfield.

Committee on Methods of Instruction — G. W. Wood (chairman), R. D. Sinclair, W. A. Munro, N. C. MacKay, W. J. Rutherford.

Note—Acording to the by-laws of the Society the chairman on each standing committee retires automatically each year and the next senior member becomes chairman. This year the retiring chairmen were both re-appointed as members of their respective committees.

Th officers elected for the year are as follows: Honorary Presidents, Hon. Albert Prefontaine, Hon. C. M. Hamilton, Hon. George Hoadley; Honorary Vice-Presidents, Dr. Jas. McLean, Dr. W. C. Murray, Dr. H. M. Tory; President, Prof. J. M. Brown; Vice-President, Prof. A. M. Shaw; Secretary-treasurer, L. T. Chapman.

A total of 55 members was enrolled during the year.

The next annual meeting will be held in Manitoba, either at Winnipeg or Brandon, during the week of the Brandon Winter Fair in March, 1928.

L. T. Chapman, Secretary.

La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

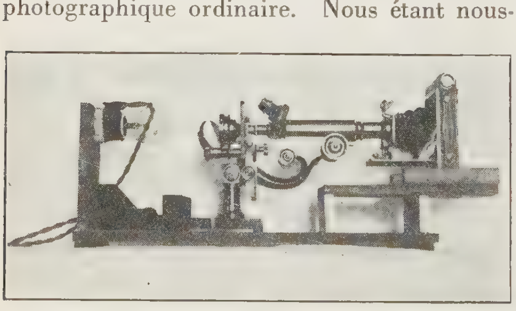
Quelques Observations sur la Photomicrographi

OMER CARON

Botaniste, Ministère de l'Agriculture, Québec

Il est inutile de vanter les avantages de la photomicrographie dans les observations et les recherches biologiques parcequ'elle constitue une documentation fidèle à laquelle il faut souvent avoir recours pour conserver l'image de certaines structures délicates qui disparaissent ou sont profondément altérées dans la confection des préparations permanentes.

Si les spécialistes bien outillés peuvent exécuter un excellent travail en photomicrographie, il n'en est pas ainsi des observateurs ou chercheurs isolés, disposant de faibles ressources, qui ne peuvent pas se payer le luxe de posséder des appareils modernes pour faire les travaux élémentaires qu'ils voudraient exécuter. Nous voulons cependant leur dire et leur démontrer par des exemples que pour faire de la photomicrographie passable il n'est pas nécessaire de posséder une installation dispendieuse et qu'il suffit à la rigueur d'avoir à sa disposition un microscope ordinaire avec un appareil photographique ordinaire. Nous étant nous-



Installation photomicrographigo ayant servi à produire les quatre gravures Qui accompagnent cet article.

même déjà servi d'une installation fort si ple avec succès, nous croyons que sa d cription pourrait être de quelqu'utilité à ce qui sont dans les mêmes conditions où no étions alors.

L'installation dont nous montrons une g vure a servi à donner les quatre images lustrant cet article. Nous croyons ces g vures capables de satisfaire les plus difficil Ainsi, les spores représentées sur la gravu No. III montrent des réticulations délica qu'on ne voit pas toujours à l'oeil en obs vant dans l'instrument.

Appareil

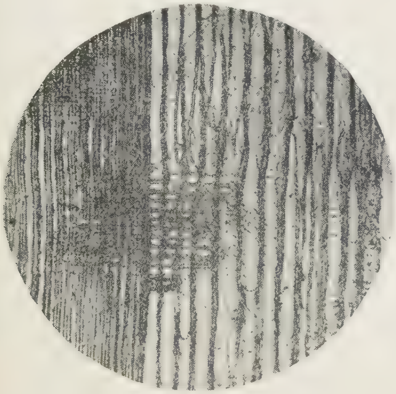
L'installation comprend un bâti en b destiné à recevoir une lampe d'éclairage, microscope et la chambre de l'appar photographique. Un coup d'oeil sur la g vure ci-contre remplacera avantageuseme la description que nous pouvons en donn L'éclairement se fait ici au moyen d'une a poule à incandescence sphérique, à filame court et l'appareil photographique est to simplement un Brownie pliant No. 2, prena des poses de $3\frac{1}{4} \times 2\frac{1}{4}$ pouces sur pellicu En faisant une telle disposition, il faud naturellement que les axes optiques des de instruments se correspondent ainsi que faisceau de lumière par rapport à ces ax C'est pour obtenir ces correspondanc que l'on se sert d'un bâti en bois qui perm de toujours remettre les pièces dans la bon position, chose qui est très longue à fa autrement.

Lorsque l'appareil photographique est co struit de manière à pouvoir faire le mise point entre les poses, il est fort facile d'o

tenir une bonne photographie. On peut alors enlever l'oculaire du microscope et l'objectif de l'appareil et projeter directement l'image de la préparation au fond de la chambre noire. Mais lorsqu'on possède un appareil fermé qui ne peut s'ouvrir entre les poses, comme celui qui est représenté dans la gravure, et que par conséquent il est impossible de contrôler la netteté de l'image sur un verre dépoli, qui sert de mise à point, il est possible d'obtenir une image nette au niveau de l'écran en tenant compte du principe suivant: Lorsqu'un oeil normal perçoit une image nette en regardant dans un microscope, cette image se trouve à point sur la plaque d'un appareil photographique réglé sur l'infini et substitué à l'oeil. Cela n'est vrai qu'en laissant toutes les lentilles aux deux appareils et en collant presque la lentille de l'appareil photographique à celle du verre d'oeil du microscope.

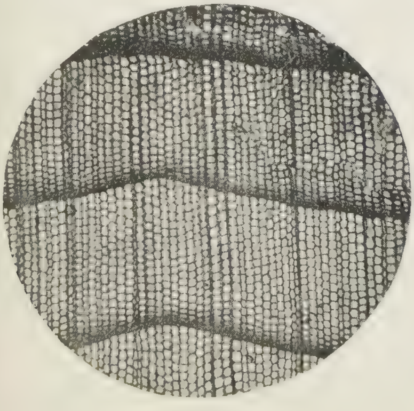
Nous avons parlé d'un oeil normal parce-que la mise à point microscopique peut varier suivant l'oeil de l'observateur. Dans le cas d'un opérateur dont l'oeil est myope, presbyte ou hypermétrope il est évident qu'on devra faire la mise à point avec les verres qui servent à corriger sa vue. Quand aux personnes qui s'obstinent à ne pas porter de verres pour corriger leur vue défectueuse, elles ne pourront obtenir de résultat satisfaisant avec ce dernier procédé.

On dit ensuite qu'un appareil est réglé sur l'infini lorsque sa lentille est avancée de manière à ce que l'image du lointain soit nette sur le verre dépoli ou la plaque sensible. C'est le 100 pieds des petits appareils. Malgré les prétentions des constructeurs prêts à jurer que leurs appareils sont réglés au sortir de la fabrique, il est bon d'en faire la vérification avant d'entreprendre des travaux délicats. Nous ne doutons pas que l'échelle



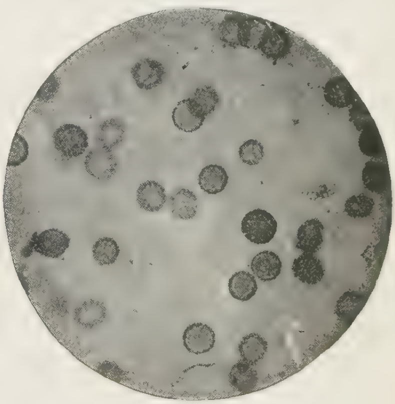
I

Section radiale de bois de conifère × 66 (Cl. O.C.)



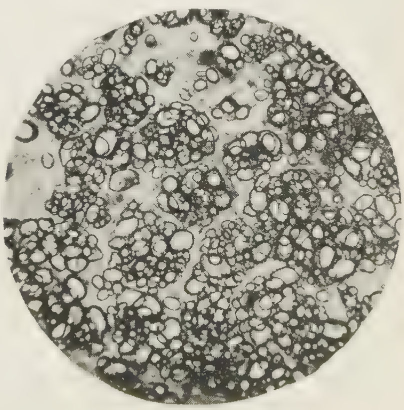
II

Section transversale du cèdre × 36 (Cl. O.C.)



III

Spores de la Carie du blé × 260 (Cl. O.C.)



Section de pomme de terre × 66 (Cl. O.C.)

graduée soit mathémathiquement bien construite mais sa position peut être défectueuse sur la table. Nous avons du dernièrement en déplacer une sur un appareil qui avait coûté plus de cinquante dollars. Notons cependant que pour la mise à point préconisée, les résultats seront sensiblement meilleurs avec les petits appareils photographiques qu'avec les gros. Les résultats ne sont pas bons non plus lorsqu'on se sert d'objectifs microscopiques très faibles parceque la correction de leurs lentilles n'est pas suffisante et que le foyer chimique diffère trop du foyer physique.

Comme les expérimentateurs peuvent se servir d'instruments fort différents et de sources lumineuses fort différentes pour prendre leurs poses, il est impossible de fixer un temps optimum pour l'exposition, ce temps varie aussi avec le grossissement, la nature les lentilles des deux appareils, l'objet à photographier de sorte qu'il est nécessaire de faire des poses d'essai. Pour les exemples que nous donnons, les temps de pose ont varié entre vingt secondes et trois minutes. Cependant la faiblesse du cliché No. III est due à une sous-exposition ce qui nous prouve que nous aurions du donner au moins cinq minutes. -

Pour les grossissements en dessous de 100 diamètres, on enlève le condensateur mais dans ce cas, il sera bon d'employer une ampoule neigée lorsque l'on se sert d'une lampe à incandescence. Le diaphragme du microscope se règle comme pour l'observation oculaire, ce qui veut dire qu'il ne faut pas le déranger après avoir fait la mise à point. Le diaphragme de l'appareil photographique n'a plus sa raison d'être ici au point de vue politique mais il est bon cependant de le fermer un peu pour éviter les réflexions des lentilles sur l'écran, ce qui pourrait causer du voile.

Le succés en photographie ne dépend pas seulement d'une mise à point rigoureuse et d'une pose convenable mais aussi d'un developpement soigné. En effet, le développement bien fait peut corriger d'assez grand écarts de pose.

Une bonne photographie doit avoir à la fois du "détail" et du "contraste" et les différents révélateurs employés peuvent exaggérer ces qualités contraires l'une à l'autre mais qui doivent se trouver ensemble sur une photographie dans la mesure voulue. Dans la pratique, nous préférons nous servir d'un révélateur à details pour le phototype (négatif) et d'un révélateur à contraste pour le photogramme (positif). Un révélateur à contraste accentuera même les détails du premier cliché. Le balancement du détail et du contraste est plus facile à obtenir lorsqu'on ne vise qu'à une seule de ces qualités dans chaque opération.

Aprés avoir essayé une vingtaine de formules différentes, nous nous sommes arrêtés aux suivantes qui peuvent suffire dans presque tous les cas.

Pour les négatifs. (Formule de Land)

Hydroquinone	8 grammes
Métol	3 grammes
Sulfite de soude sec ..	30 grammes
Carbonate de soude sec .	30 grammes
Bromure de Potassium .	2 grammes
Eau Q.S. poure faire ..	1000 c.c.

Les ingrédients se dissolvent dans l'ordre et à froid. La solution peut se conserver six à huit semaines.

Pour les positifs.

Eau à 125 F.	500 grammes
Elone	4 grammes
Sulfite de soude	75 grammes
Hydroquinone	10 grammes
Carbonate de soude	30 grammes
Bromure de Potassium .	4.7 grammes
Eau Q.S. pour faire	1000 c.c.

Cette derniére formule est la méme que celle donnée par la Eastman Kodak Co. sous le nom de Formule "Process," excepté que la carbonate de potasse est remplacé par du carbonate de soude en augmentant légèrement la quantité. Nous préférons le carbonate de soude au carbonate de potasse parce qu'il est moins hygroscopique. Les ingredients doivent se dissoudre à chaud, dans l'ordre donné et la solution peut se conserver deux à trois mois. Il existe aussi d'autres excellentes formules parmi celles à deux ou plusieurs solutions mais nous n'avons cité que les deux précédentes qui peuvent suffire dans presque tous les cas, se conservent bien et se préparent dans une seule solution.

Nous nous estimerions heureux si les notes précédentes pouvaient être utiles à quelques travailleurs. Nous ne prétendrons pas que

l'on réussira toujours en les suivant, du moins au début, parce que l'entrainement est un facteur qui compte beaucoup dans tous ces genres de travaux.

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Que Faut-il Penser des Choux de Siam ?

ANDRE AUGER,

Inspecteur aux fermes de démonstration, Ministère de l'Agriculture, Québec.

Dans un article publié dans la page agricole de l'Action Catholique du 24 Décembre, 1926, l'auteur, un professeur de chimie, après avoir mis en doute certaines assertions faites antérieurement dans le même journal par M. Joseph Ferland, I.A. semble vouloir prouver que la culture des choux de Siam a été une faillite sur la plupart des stations expérimentales au point de vue des profits laissés par cette culture, soit qu'on considère le profit net laissé à l'arpent, soit le surplus du rendement laitier lorsque les racines ont fait partie des rations.

Un mot d'abord des chiffres de M. Ferland, Si fabuleux peuvent ils paraître, je suis convaincu qu'ils peuvent être exacts. Prenons le profit net le plus élevé, soit: $131.70 à l'arpent. Supposons un rendement de 25 tonnes à l'arpent, ce qui est un beau rendement, il est vrai, cans cependant être extraordinaire. Si le cultivateur qui produit ces légumes, au lieu de les faire consommer par ses vaches, les a vendus, disons: $0.50 le sac, ce qui fait un peu plus de $11.00 la tonne, il a réalisé $275.00 avec cette vente.—$275.00 —$131.00 fait $163.00 pour le coût de production à l'arpent. Les pucerons et les vers gris ont pu exiger beaucoup de son empoisonné ou de chaux pour que le coût de production d'un arpent de choix de Siam s'éléve à $163.00.

En 1924, sur les 21 fermes de démonstration du Ministére de l'Agriculture de Québec, le coût de production des choux de Siam a été le suivant:

	à l'arpent	par tonne
moyen:	$68.54	$3.55
maximum	$122.20	$8.64
Minimum	$40.90	$2.27

Le rendement moyen à 1 arpent cette même année a été pour les 21 fermes mentionnées de 19.3 tonnes à l'arpent, alors que le plus gros rendement était de 32 tonnes et le plus faible de 8.7 tonnes. Quant aux profits nets laissés à l'arpent par la culture des choux de Siam, nous n'avons pas de chiffres aussi éloquents que ceux de M. Ferland, notre base d'évaluation n'étant pas tout à fait la même, puisque chez nous la valeur des choux de Siam est en rapport de celle du foin.—

Cependant ces profits nets étaient les suivants:

	à l'arpent	par tonne
Moyen	$8.86	$0.45
maximum	$49.24	$1.73
minimum ...	$60.36(perte)	$4.64(perte)

Notons en passant que six fermes sur vingt et une ont cultivé les choux de Siam à perte cette année-la. Il ne faudrait pas conclure du fait qu'un tiers des régisseurs de fermes de démonstration ayant cultivé les choix de Siam à perte il faille reléguer dans l'ombre cette culture. Il est plus sage, croyons nous, de toucher du doigt la cause de mal; dans la plupart des cas, c'est un manque de soins suffisants apportés a cette culture qui fut la cause de l'insuccès, d'un rendement trop faible pour laisser des profits. Mais outre les profits immédiats que peut laisser la culture des racines, il ne faut pas oublier de tenir compte de l'amélioration que cette culture a laissée dans le sol. Dans le bulletin No. 56, M. l'abbé H. Bois dit: "Un sol qui a été bien préparé pour les racines, ameubli profondément et parfaitement nettoyé, se trouve dans les meilleures conditions pour donner de fortes récoltes de céréales et former une excellente prairie.

Dans le même bulletin, M. Bois cite M. Bénard, un agronome francais, qui dit: "Nulle plante n'améliore le sol et n'est favorable aux récoltes subséquentes comme la betterave et, dût-elle ne me rien rapporter, je continuerai à la cultiver tant sont grands ses avantages pour l'amélioration de mes terres et pour les cultures qui suivent."

Le Chef du Service de la Grande Culture à Québec, M. L. P. Roy, dit dans le bulletin 91,p.40: "Les cultures sarclées, lorsqu'elles sont bien faites et qu'elles recoivent les soins requis,ont une action reconstituante sur le sol. Les fumures et les nombreux travaux culturaux qu'elles recoivent restaurent la fertilité du sol et améliorent ses propriétés physiques."

Or, de toutes les cultures sarclées, celle qui comporte le moins de risques à tout point de vue, c'est certainement celle des choux de Siam. Dans le bas de Québec tout particulièrement la culture des choux de Siam est la seule qui puisse assurer avantageusement une nourriture aqueuse aux vaches en hiver. C'est ce qui nous amène à traiter le deuxième point de la question.

Les expériences sur lesquelles le professeur de chimie appuie sa thèse peuvent avoirleur valeur dans les états du Michigan et du Wisconsin, mais elles n'en ont guère dans notre province, surtout dans la région du bas de Québec. La conclusion qu'on peut en tirer, c'est qu'au Michigan et au Wisconsin, où la culture du blé d'Inde est si facile, les choux de Siam viennent au second plan, parce qu'il est incontestable que l'ensilage de maïs, surtout celui qui se fait aux Etats-Unis, est supérieur aux racines comme aliment pour une vache laitière. D'autre part l'expérience de Morrison ne prouve absolument rien, ni pour ni contre les choux de Siam, puisque la vache dont il est question recevait déjà une ration suffisamment riche, trop riche même pour produire économiquement les 22.5 lbs de lait qu'on lui attribue. (Cette vache recevait 9.2 lbs de concentrés, 5 lbs, de trèfle et 30.8 lbs. d'ensilage. Quand à cette ration on a ajouté 18.2 lbs. de racines, l'augmentation en lait a été de 1.3 lbs, ce qui fait pour une tonne de racines: 142 lbs. de lait).

Ceux qui ont voyagé un tant soit peu dans le bas de Québec savent quelle qualité de foin on y récolte la plupart de temps. Très rares, je crois, sont ceux qui ne seraient pas prêts à admettre que les choux, de Siam sont l[a] récolte par excellence pour le complémen[t] d'une ration lorsqu'on ne peut avoir d'ensil[-] age. Qu'on fasse donc une expérience dan[s] les conditions, ordinaires de ces cultivateurs et peut-ètre trouvera-t-on qu'avec une ratio[n] de 40 lbs. de choux de Siam par jour le[s] vaches de cette région accuseront une aug[-] mentation de plus de 1.2 lbe. de lait par jour. Et puis croit-on que les cultivateurs de cett[e] région seront prêts a donner 9 livres de con[-] centrés par jour à une vache de 22 lbs. d[e] lait s'ils ne sont pas déjà des fervents de choux de Siam?

Non la culture des choux de Siam n'est pa[s] si facile à remplacer et je ne crois pas "qu'i[l] soit opportun de laisser un peu dans l'ombr[e] les racines pour pousser davantage la cultur[e] des fourrages verts, culture moins aléatoir[e] et qui coute meilleur marché."

Cette dernière phrase nous semble asse[z] étrange quand on songe que la semence d[e] fourrage vert à elle seule revient presqu[e] aussi cher à l'arpent qu'une tonne d[e] choux de Siam (prix moyen: $8.64). N[e] sait-on pas que cette culture est beaucou[p] plus exposée aux mauvaises conditions clim[-] atériques, étant donné la difficulté du sé[-] chage?

L'auteur se reporte à soixante ans en ar[-] rière pour parler des facilités avec lesquelle[s] on se procurait de la main-d'oeuvre; il parl[e] de machines perfectionnées, mais où sont elle[s] donc ces machines perfectionnées qui auron[t] raison d'une abondante récolte de fourrag[e] vert, si par hasard la verse se met de la par[-] tie.

Et puis je prendrai un cas typique qu[e] je soumettrai à l'auteur. Sur une ferme d[u] nord du comté de Terrebonne, terre d[e] sable, très pauvre, (il y en a plusieurs comm[e] cela dans le bas de Québec) ce que l'o[n] estimait être une bonne récolte de foin l'a[n] dernier (1926) a produit exactement un tier[s] de tonne à l'arpent: l'avoine a rendu 1[-] minots à l'arpent, le fourrage vert une tonn[e] sur terrain amélioré et un quart de tonn[e] ailleurs, tandis que les choux de Siam on[t] donné 18 tonnes à l'arpent. (avec une appli[-] cation de 12 tonnes de fumier pas trop bon)[.] (Veut-on savoir quels ont été les résultat[s] obtenus avec le fourrage vert sur les 21 fer[-] mes de démonstration du Ministère de l'Agric[-] ulture de Québec en 1924. (Disons tout d[e] suite que de ce nombre deux fermes seule[s]

ıent ont produit du fourrage vert avec pro-
t). Les rendements ont été les suivants:

moyen:	2.5 tonnes à l'arpent
minimum	0.9 tonnes à l'arpent
maximum	6. tonnes à l'arpent

Coût de production

	à l'arpent	par tonne
maximum	$55.16	$27.74
moyen	$28.96	$11.71
minimum	$17.44	$ 4.76

Profits Net

	à l'arpent	par tonne
moyen ...	$ 9.17(perte)	$ 3.71(perte)
minimum .	$23.19(perte)	$19.74(perte)
maximum..	$13.24	$ 3.24

.e fourrage vert évalué à $8.00 la tonne).
quelle des deux cultures est plus payante, choux de Siam ou les fourrages verts? quelle des deux laisse le sol en meilleure ndition?

Le fourrage vert est nécessaire en été, nme complément du paturage, très utile hiver s'il a été bien fait; il complète bon système de rotation, mais il ne doit remplacer les choux de Siam quand il possibilité de les récolter. Du reste, con- nner une culture et vouloir la supplanter une autre me semble une injustice. Toute ture peut avoir son coté pratique. Dans cas des choux de Siam et de fourrage vert vise le même but, produire une nourriture ieuse, mais dans des circonstances différentes, puisque l'une doit servir en été et le cas des choux de Siam et de fourrage vert ait encore sa place dans les rations d'hiver, il n'en perd pas moins sa principale qualité, celle d'être une nourriture aqueuse, parce que pour le bien conserver il faut le faire sécher. Il est vrai qu'on peut lui conserver cette propriété en le mettant en silo, mais il reste à prouver s'il serait pratique de construire un silo pour la conservation de nos fourrages verts.

Une autre injustice qui, à mon point de vue, se commet très souvent à l'égard d'une culture quelconque, c'est l'appréciation de son rendement au point de vue matière sèche. S'il nous fallait surtout viser à obtenir de la matière sèche avec une culture, autant vaudrait révolutionner toutes nos méthodes culturales et rechercher les plantes les plus fibreuses. Mais, sans aller plus loin, ce principe de la matière sèche des aliments me semble fortement en contradiction avec les principes des experts en alimentation, qui recommandent, surtout pour les fourrages grossiers de les couper au moment de la floraison, alors que le pourcentage de matière sèche est précisément le plus faible.

Et puis les analyses ne prouvent-elles pas que cette même matière sèche est plus digestible quand les fourrages eux-mêmes sont plus abondamment pourvus d'eau. Ce n'est donc pas tant la matière sèche elle-même qui compte mais sa digestibilité.

Activites des Sections.

Section de Montréal

.e 26 février dernier, Monsieur J. E. Thér- t, directeur de l'Ecole de laiterie et du oratoire agricole provincial de St. Hya- he, était le conférencier du diner-causerie isuel de la Section de Montréal, au Cercle versitaire.

Monsieur Thériault fut présenté par le sident, H. M. Nagant, qui insista sur l'im- ance de la double fonction qu'il exerce l'organisation technique de l'agriculture a province.

e conférencier, qui a eu l'occasion de se ialiser à New-York, dans la microbiologie chimie des produits laitiers, traita d'une premières conditions essentielles dans lustrie laitière: La production hygiénique ait.

fit une analyse approfondie des diverses causes de contamination, de souillure et d'altération de ce produit si délicat et si sensible aux agents physiques, chimiques et biologiques. Il fit aussi ressortir d'une façon très vive, combien une foule de pratiques courantes dans la manipulation du lait, le lavage des récipients, etc. sont irrationnelles et la cause de contaminations multiples, alors que la plupart du temps, les gens les considèrent comme très efficaces et une garantie de propreté et de bonne conservation.

Monsieur Aimé Gagnon, professeur à l'Institut Agricole d'Oka, remercia monsieur Thériault, au nom des 24 auditeurs réunis au Cercle Universitaire malgré les circonstances peu favorables dues au mauvais temps et l'envoi quelque peu tardif des convocations.

H.M.N.

R. H. ABRAHAM

Robert H. Abraham died in the Chatham hospital, Chatham, Ont., on Saturday, March 26th, following an operation for mastoid. The funeral was held at Chatham on March 29th.

R. H. Abraham was born at Chatham, Ont., January 16th, 1882. He graduated from the Ontario Agricultural College in 1916, and since that time has been employed under the Dominion Department of Indian Affairs, with headquarters at Chatham, having charge of agricultural work among Indians in Ontario, engineering work on reservations, etc.

He is survived by his widow and five children.

G. J. JENKINS

G. J. Jenkins died at Sydenham, Ont., on February 23rd. Mr. Jenkins graduated from the O.A.C. in 1913, was Bacteriologist for the Ottawa Dairy at Ottawa and the Farmer's Dairy Co. at Toronto and, since 1923, had been local Manager at Sydenham for the Farmer's Dairy Co. He was born at Meaford, Ont., on February 5, 1887. The funeral was held at Toronto.

WILLIAM LOCHHEAD

William Lochhead, Emeritus Professor of Entomology of Macdonald College (McGill University) died at Ste. Anne de Bellevue, P.Q., on Saturday, March 26th. He retired from active work about two years ago and since that time has been living at Ste. Anne's, within sight of the buildings of Macdonald College, where he spent so many years. His illness, which was due to a heart condition, did not become serious until the early part of 1927.

William Lochhead was born on April 3, 1864, at Listowel, Ontario. He received his B.A. degree from McGill University in 1885, and his M.Sc. from Cornell University in 1895. He joined the staff of the Ontario Agricultural College in 1898, occupying the position of Professor of Biology at that institution until 1906. Before going to Guelph he had been Science Master in the Collegiate Institutes at Galt, Perth and London, Ont.

When Macdonald College was in course of construction in 1906, Professor Lochhead was appointed to the staff as Professor of Biology, a position which he held until 1920, when the Department was divided. From 1920 until his retirement in 1925 he was Professor of Entomology and Zoology. From that date he remained identified with Macdonald College as Emeritus Professor of Entomology, an honour conferred upon him by McGill University.

At its Annual Convention in 1926, the Canadian Society of Technical Agriculturists, of which Professor Lochhead was a charter member, conferred upon him the Society's Fellowship for distinguished service to the profession. He was also a Fellow of the American Association for the Advancement of Science.

Shortly after his retirement, his portrait was painted by G. Horne Russell, P.R.C.A., on subscription of his colleagues, pupils, associates and friends, and hung in the Library of Macdonald College. A copy of this portrait is being mailed to every member of the C.S.T.A., with this issue of its official organ.

Professor Lochhead is survived by his widow and by one son, Dr. A. G. Lochhead, Dominion Agricultural Bacteriologist at Ottawa.

The funeral service was held at Ste. Anne de Bellevue on March 29th, and burial took place in Mount Royal Cemetery, Montreal.

Concerning the C.S.T.A.

APPLICATIONS FOR MEMBERSHIP

The following applications for regular membership have been received since January 1st, 1927:—

Anderson, J. A. (Alberta, 1926, B.S.A.) Edmonton, Alta.
Banks, A.B. (Toronto, 1926, B.S.A.) Stewiacke, N.S.
Brown, D. A. (Manitoba, 1920, B.S.A.) Morden, Man.
Brown, R.C. (Manitoba, 1926, B.S.A.) Pilot Mound, Man.
Cook, W. H. (Alberta, 1926, B.S.A.) Edmonton, Alta.
Curran, C. H. (Toronto, B.S.A.) Ottawa, Ont.
English, H. O. (Manitoba, 1913, B.A., 1915, B.S.A.) Victoria, B.C.
lack, G. L. (Alberta, 1919, B.S.A., 1920. M.A.) Lacombe, Alta.
lewelling, H. N., Sussex, N.B.
loyd, L. T., Winnipeg, Man.
raham, A. J. (Toronto, 1923, B.S.A.) Beamsville, Ont.
utteridge, H.S. (British Columbia, 1925, B.S.A.) Ottawa, Ont.
ill, H. (McGill, 1925, B.S.A.) Ottawa, Ont.
illier, R. R. (Toronto, 1923, B.S.A.) Toronto, Ont.
unter, G. (Toronto, 1919, B.S.A.) Niagara-on-the-Lake, Ont.
afresnière, E. (Montreal, B.S.A.) Quebec, P.Q.
ennox, W. J. W. (Toronto, 1905, B.S.A.) Toronto, Ont.
iller, H. E. (Toronto, 1926, B.S.A.) Windsor, Ont.
cAllister, J. W. (Alberta, 1926, M.Sc.) Edmonton, Alta.
gilvie, A. E. (British Columbia, 1924, B.S.A.) Victoria, B.C.
'Neill, L. A. (Toronto, 1918, B.S.A.) Toronto, Ont.
earsall, L. W. (Toronto, 1922, B.S.A.) Toronto, Ont.
ott, G. W., Edmonton, Alta.
nith, G. L., Toronto,, Ont.
. Denis, J. M. A. (Montreal, 1926, B.S.A.) Plantagenet, Ont.
Stirrett, G. M. (Toronto, 1922, B.S.A.; Purdue, 1924, M.S.; Minnesota, 1926, Ph.D.) Chatham, Ont.
Tarr, H. L. A. (British Columbia. 1926. B.S.A.) Vancouver, B.C.
Thomson, W. J. (Alberta, 1926, B.S.A.) Edmonton, Alta.
Walker, G. B. (Manitoba, 1920. B.S.A.) Claresholm, Alta.
Weir, W. A., Toronto, Ont.
Whitbread, B. J. (Alberta, 1918, B.S.A.) Vermilion, Alta.

The addition of these names brings the total membership to 1,000, composed of 6 Honorary members, 12 student members and 982 regular members. The List of Members has gone to press and is now being mailed to every member. Approximately 80 per cent. of the members have paid their fees for the current year and it is expected that the remainder will do so before May 31st, when the year ends.

It should be a matter of considerable pride to every member of the Society that its objective of one thousand members has been reached. Numerically the C.S.T.A. compares favourably with any other professional body in Canada. It is thoroughly organized in every province and has its own publicity medium. It should now be in a position to consolidate itself, devoting less effort to membership campaigns and more effort to the accomplishment of its objects. Many members feel that the Society has not made itself sufficiently known, that its accomplishments have not been spectacular enough and that, individually, they have not received adequate returns for their investment. Such members should realize, first of all, that before any organization can function fully and properly, it must be representative of its profession, which means a constant membership campaign. It must also be organized efficiently. It has taken a long time to complete this work, perhaps longer than has been the case with other professions, for reasons which should be quite obvious.

The fact should also be appreciated that the C.S.T.A., chiefly through its magazine,

has gained for the agricultural profession in Canada a world-wide recognition. Its standing committees have done a great deal of work which could not have been accomplished except through organized effort. Its local branches and its annual Conventions have had a noticeable effect upon the relationships existing between the various agricultural agencies in Canada—provincial, federal and institutional. These things may not benefit the individual member, but they could not have been accomplished without organization, and no organization can function without a large and loyal membership.

The C.S.T.A. will make more rapid progress in future if every member will make certain resolutions: (1) to be proud of his membership and loyal to the Society; (2) to pay his fees promptly, not begrudging the $5.00 annually but rather with a feeling of thankfulness that the fee is not larger; (3) to contribute articles to the magazine whenever possible, realizing that *Scientific Agriculture* is now a recognized medium for the publication of articles dealing with agricultural research, experimentation, education and extension; (4) to attend meetings of the Society whenever possible; (5) to offer constructive suggestions and criticisms; (6) to notify the General Secretary promptly of any change in position or address; (7) to support the advertisers, who are financing the entire cost of publishing the official organ and (8) to encourage non-members to join the Society. If every member would make these resolutions and carry them out to the best of his ability the Society would give astounding returns in a very short time.

NOTES

J. W. Scannell (McGill '21) is now at the Dominion Laboratory of Plant Pathology, Indian Head, Sask.

P. C. Connon (O.A.C. '20) who has been Field Supervisor under the S.S.B. at St. Catharines, Ont., for the past few months, has returned to his farm at Markham. He has been succeeded at St. Catharines by E. N. Buckley (O.A.C. '23).

E. C. Hatch (O. A. C. '20) is an advertising representative with the Consolidated Press. His headquarters are at Montreal.

E. C. Hallman (O.A.C. '02) is manager of the Oliver Government Farm at North Edmonton, Alta.

E. C. Stillwell (O.A.C. '19) has been appointed to the staff of the Ontario Agricu tural College, in charge of meat researc He was lecturer in Animal Husbandry at t University of B.C. from 1920 until 1922 a Assistant in Animal Husbandry at the Unive sity of West Virginia from 1923 until t time of his appointment at Guelph.

C. M. Learmonth (O.A.C. '10) was a pointed Secretary of the Western Cana Live Stock Union at its recent meeting Winipneg.

F. F. McKenzie (British Columbia '21) h accepted a position as Professor of Agricu ture at the International College, Smyrn Turkey in Asia Minor, and expects to ta up his duties in September next. He h been Agent in Animal Husbandry under t U.S. Bureau of Animal Industry since Se tember, 1923, with headquarters at the Un versity of Missouri.

W. S. VanEvery (O.A.C. '22) has resign his position as Agricultural Representati at St. Catharines, Ont., to enter the insuran business. He has been succeeded by E. Neff (O.A.C. '15) formerly Agricultur Representative at Athens, Ont.

CONVENTION COMMITTEES

The British Columbia local has appoint the following committees to take charge arrangements for the Seventh Annual Co vention which is to be held at Vancouv from June 16th to June 18th, 1927:—

RECEPTION—P. A. Boving (chairman), Rive, I. T. Barnet.

PROGRAMME—H. M. King (chairman), Tice, G. E. W. Clarke.

ENTERTAINMENT—A. F. Barss (chairman D. G. Laird, W. H. Robertson.

PUBLICITY—F. E. Buck (chairman), R. Palmer, E. W. White.

CORRECTION.

In the list of new members which w printed on page 185 of the issue of Janua last, Mr. L. J. Briand was credited with t degree of M.S.A. from McGill Universit Mr. Briand has drawn our attention to t fact that his thesis for this degree has yet be completed. He received his B.S.A. degr from Laval University in 1921.

The General Secretary attended the A nual Meeting of the Western Ontario loc at Toronto on March 10th, and the Niaga Peninsula local at Grimsby on March 12

The World's Poultry Congress.

ERNEST RHOADES

Congress Secretary

THIS year Canada reaches the pinnacle of her poultry endeavour. On July 27th next His Excellency the Governor General, the Viscount Willingdon, will extend an official welcome to the delegates to the World's Poul-:ry Congress. His Excellency will be sup-ported by the Prime Minister, the Right Hon-orable W. L. Mackenzie King, the Lieutenant Governors of the Provinces, Cabinet Ministers and Provincial Premiers. Some forty na-:ions through their official representatives will reply to the Governor General, and the third of these World Poultry Congresses will be officially open.

In 1912 representatives of several nations net in London, England, organized the In-ernational Association of Instructors and nvestigators in Poultry Husbandry, named Edward Brown as the President of the or-anization and planned the first real repre-entative gathering of world poultrymen for 1916. For obvious reasons this gathering id not take place, but as soon as interna-onal relations were re-established another neeting was held. The poultrymen of the orld were the first to meet after November 1918, in an endeavour to establish interna-onal relations upon their old footing. As result of this meeting the first World Con-ress of poultrymen was held at The Hague 1921.

This first Congress at The Hague was ld under the distinguished patronage of eir Majesties the Queen Wilhelmina and the ueen Mother of Holland, and under the esidency of His Royal Highness Prince enry of the Netherlands. The Congress was success and Canada was unfortunate in not ing represented. At The Hague, Spain ten-red an invitation for the second Congress meet at Barcelona, and at this Canada was e of the chief participants. The Congress is held in 1924 under the distinguished patronage of His Royal Highness King Alfonso XIII and H.R.H. the Prince of the Asturias. As soon as the second Congress was planned Canada commenced to take an interest, and worked to such purpose that the exhibits she sent to Barcelona not only captured the attention of the world through their excellence, particularly the live birds, but they made the representatives of other countries anxious to see at first hand the working out of the policies which had made such development possible.

The Canadian delegates to the second Congress at Barcelona took with them an invitation from Canada for the third Congress to meet here in 1927. This invitation was very favorably received, and eventually accepted.

The object of World Poultry Congresses is to bring together those interested in any phase of poultry work with the purpose of stimulating interest in world poultry affairs, coördinating education and research internationally, educating in the most efficient methods of production, standardization, distribution and cooperation, through graphical exhibits to illustrate important phases of the poultry industry, and to promote international acquaintance and good fellowship among the nations of the world.

The President

Fifty years ago a young Englishman who kept a few hens saw great possibilities in what was a more or less neglected industry, a side line, something kept for what returns it might give, if it felt like giving any. The fact that the hen could be changed from a farm scavenger to a veritable mint had occurred to only a very few. This young man had vision, and determined to make the humble hen a life study.

The man was Edward Brown, known to this generation as the father of the International Association of Instructors and Investigators in Poultry Husbandry. He is no stranger to Canadian poultrymen, and during the next few months, and for years afterwards he will be remembered by us as the man who

presided over the largest international gathering ever assembled to study a particular branch of the live stock industry. Canada will help Edward Brown to celebrate his 'Poultry Jubilee'—fifty years of hard work, and striving for recognition for an industry in which he saw wonderful possibilities. The success of these World Poultry Congresses is evidence of the justification of the optimism at all times in evidence in Edward Brown's work and writings.

The Papers

The papers presented in the Breeding, Disease, Nutrition, Marketing, Extension and General sections will embrace every phase of the industry, and those delivering the papers are known as our foremost scientists. These technical and practical men drawn from the great Universities of the United States, Europe, Great Britain, the genetic stations, state laboratories, the great commercial firms, etc., etc., while dealing with problems that affect poultry, cover much wider fields and their work is applicable to all branches of technical agricultural endeavour.

It is probably here that the members of the C.S.T.A. will find the most to interest them, and they cannot afford to miss the opportunity afforded of listening to and meeting these men.

As copies of the Final Announcement and Program have been mailed to all members of the C.S.T.A. it is not necessary to refer here to the actual papers that will be presented, but it might be of assistance to a better understanding of the Congress to say something about the exhibition.

The Exhibition

On the afternoon of Wednesday, July 27, His Excellency the Governor General, the Viscount Willingdon, accompanied by Lady Willingdon, will declare open the Congress Exhibition. It is at the exhibition that the actual commercial significance of poultry will be proved. It will show that the industry interests king and commoner alike, the new and the old world, the east and the west, the north and the south. Thousands of birds will be in evidence from Japan and India, Egypt, Spain, Holland, Great Britain, and others of the points of the compass. The policies respecting poultry in operation in Italy, Germany, the United Socialist Soviet Republic, and twenty other countries will be illustrated, and the efforts to interest the younger generation will be actually demo strated by the United States through Boy a Girl Competitions.

The exhibition will occupy all the buil ings on the Central Canada Exhibiti grounds. The work of preparing these buil ings for the exhibits is in the hands of M J. O. Turcotte, Canadian Exhibition Commi sioner, and nothing more need be said rega ing this work beyond the fact that Mr. T cotte was responsible for the wonderful hibits staged by Canada at the British E pire exhibition. Those who were privileg to see the exhibits at Wembley know that work will be well done.

The Congress Organization

Probably the most enthusiastic suppor of the Congress in Canada is the Minister Agriculture, Hon. W. R. Motherwell. It w due to his foresight that the invitation w originally extended for the Congress to co to Canada, and in all the preliminary wo he has taken a very keen interest and rend ed every assistance possible to the officers w whom he entrusted the working out of details of this big undertaking. Dr. J. Grisdale, the Deputy Minister of Agricultu presides over a large Congress commit which consists of the provincial Ministers Agriculture, Federal and provincial Depa mental officials, representatives of the bre ers' organizations, the Trade, etc., and Congress executive drawn from this la committee is working under the chairm ship of Mr. F. C. Elford, Dominion Poul Husbandman, who is also General Direc of the Congress.

Congress organization has been carried to the provinces, and each has its own C gress committee under the chairmanship its Minister of Agriculture.

Publicity, transportation, accommodati exhibition, reception, function, automob entertainment, ladies' reception, tours, c toms, inspection, motion picture, lingual information bureau, grounds, and seve other committees complete the Congress ganization. The work of these committ is being directed by officials from Dep ments of the government service, and the leading citizens of Ottawa.

Membership

There are a number of men interested poultry who are members of the C.S.T

Their interest and cooperation is assured. We wish to solicit the assistance and cooperation of every other member of the C.S.T.A. There will be something of interest for all in the Congress program. The brief sketches which are given in this issue of some of the men who will take part in the Congress program are sufficient evidence of this. The Congress executive would like to enroll every member of the C.S.T.A. as a Congress member. Those who wish to secure a copy of the Report of the Congress Proceedings would be well advised to take out a full membership which may be had on a payment of $5.00. This entitles the member to a copy of the Proceedings and to admission to all the Congress sessions, the exhibition and all functions arranged for the Congress. If they wish to participate in the Congress, but do not desire to obtain a copy of the Report of the Proceedings they may do so on payment of a $3. associate membership.

Accommodation

The Congress Executive has control of all hotel, Y.M.C.A. and private home accommodation in the city of Ottawa. If you wish to make sure of comfortable quarters before the Congress, it will be necessary for you to take out your membership, and write the Congress Secretary stating what accommodation you require. Practically all hotel accommodation is reserved for foreign delegates, but as the best homes in the city are being opened to Congress delegates, this is no serious handicap.

If you are bringing adult members of your family to the Congress it will be necessary for them to take out associate membership if they wish to participate to the full in the Congress activities. Only those wearing the Congress badge, given with the membership, are entitled to free entry to the Congress functions, sessions, and exhibition.

Congress Possibilities

Much good is derived by those countries having the honor of staging a World's Poultry Congress. Some six thousand people drawn from all parts of the world will attend the Congress. They are primarily interested in some phase of poultry keeping. It is up to the people of this country to interest these delegates in Canada. Show them Canada at her best, a warm hospitable country offering her unbounded acres, her vast forests and mineral wealth, in fact all her wonderful natural resources to any and all who care to make Canada their home. If this is done the delegates will return to their own countries full of enthusiasm for Canada and her possibilities. Each and every one will become a potent factor in Canadian development along immigration lines, and the World's Poultry Congress will have accomplished a great purpose.

The Congress executive feels that technical agriculturists in Canada will give their help freely and cheerfully in whatever way they think best, and be in attendance at the Congress to take their places as hosts to the several thousands of visitors coming from other countries.

Congress Headquarters—The Chateau Laurier, Ottawa

Standardizing Eggs and Poultry.

W. A. BROWN

Chief, Poultry Division, Dominion Live Stock Branch, Ottawa.

A per capita consumption of 28.1 dozens of eggs is evidence of the popularity in Canada of this neatly parcelled food. No other country can boast of such a consumption, and many countries are asking why such a condition exists. The buying public is concerned with two main points in the purchase of food products—price and quality. Egg prices in Canada the year round range all the way from 25 cents to $1.00 a dozen, so cheapness is not much of a contributing factor to this tremendous consumption.

Quality must then be considered, and here we find the real reason why Canadians "eat eggs". Canada, one of the youngest of the nations, leads the world in the matter of the standardization of eggs. Other nations have egg standards, but Canada was the first country to base standards on the interior quality of the egg, on the actual contents of the shell. Size of egg stands for nothing unless the quality is there. Canada went even a step further, and said "our standards are good, we can depend upon and are prepared to guarantee our graded eggs, and the government is ready to stand behind them, and back them by legislation."

The process of standardizing eggs has been gradual, and when standards were first agreed upon twelve years ago, it was decided to give their application a period of test, and it was after two years of trial and observation that they were incorporated under the "Live Stock and Live Stock Products Act". These first egg regulations applied to eggs moving interprovincially and to export shipments.

Conditions That Made Standards Necessary

Eggs suffer more from indifferent marketing than almost any other farm product. Their quality not being readily apparent, permits of their exchange and sale in all stages of deterioration. The old-fashioned system of barter and exchange of eggs for goods either with huckster or at the country store offered no inducement for improvement. On the contrary, it was often more of an incenti to the continuation of careless and indiffe ent methods. In addition, the surplus in t season of plenty was held over to the seas of scarcity and all sold as fresh.

A good egg is its own best advertisemen Such eggs were no advertisement at all. ordinary trade practice in Canada before t advent of egg grading in accordance wi Canadian standards, it was customary to r move the bag eggs. The balance, howeve contained many eggs of inferior quality ar was not such as to encourage increased co sumption, the difficulty being that the hous wife, after having used all the argument po sible to ensure getting good eggs, frequent found that the first egg was no criterion what the second might be. She found eg a bad investment. The general situation w such that the Dominion Department of Agr culture decided to take a hand, and at fir turned its attention to improving productio and marketing conditions. Advice was give and groups of producers were assisted to o ganize and market their eggs cooperativel

The preparation of standards of quali was next considered. These standards we first adopted by the Canadian Produce A sociation in 1915 and they were immediate put into effect by some of the larger coope ative associations. The delay in shipmen during war time and the necessity of Cana safe-guarding her name regarding quality the British market, led to those standar being adopted legally in 1918, from whi date it was required that all containers eggs for export be marked with the name the class and grade, and that they be su ject to inspection at point of shipment b fore being shipped. This service inaugura ed Canada's inspection service on eggs whi later was extended to imports and finally domestic trade, with the result that duri the past three years all eggs sold for dome tic consumption in Canada have been offer for sale in accordance with the Canadi standards for eggs.

Before compulsory grading was required [fo]r domestic trading a thorough test was [m]ade to ascertain whether or not the consum[in]g public would respond to the standardized [pr]oduct. Arrangements were made with a [nu]mber of the leading retailers in the prin[cip]al centres in Canada, whereby with De[pa]rtmental assistance, they agreed for a per[io]d of two months to offer for sale only eggs [gr]aded in accordance with the Canadian Stan[da]rds.

Suitable material for window displays was [pr]ovided and Departmental officers supervis[ed] the grading of the stock offered for sale. [Th]e retailers' customers were fully advised [by] circular as to the project under way. The [res]ults obtained were phenomenal; each mer[cha]nt following this method of sale reported [gre]atly increased business, many of them [dou]bling and some of them actually trebling [and] quadrupling their sales of eggs. The [suc]cess of the experiment left no doubt as to [the] efficacy of national standards for grading [as] applied to domestic trading.

Egg Regulations

[T]he legislation providing for national [gra]ding is known as the "Egg Regulations", [pro]vision for which was made under the ["Li]ve Stock and Live Stock Products Act" [of 1]917. The objects of the Egg Regulations [are] two-fold:

[F]irst—To segregate eggs into their respec[tive] grades or qualities and give the consumer [an o]pportunity for selective purchase on the [bas]is of these national grades.

[Se]cond—To carry back to the producer that [th]e differential between the grades which [the] consumer has shown his willingness to [est]ablish.

[W]hile the marketing and distribution of [eggs] is carried on primarily by the whole[sale] trade, yet the standardization of the pro[duct] and the system of trading that has been [esta]blished as a result of national grading [has p]roven a great incentive to the establish[ment] of producers' cooperative marketing [assoc]iations. Of these the most notable are:

[The] Egg Pools of Alberta and Saskatchewan.

[The] Manitoba Co-operative Egg and Poultry [Ma]rketing Association.

[The] United Farmers of Ontario.

[The] Co-operative Fédérée of Quebec.

The Prince Edward Island Co-operative Egg and Poultry Association.

The Co-operative Poultry Marketing Exchange of New Brunswick and Nova Scotia.

All these associations are engaged in the assembling and grading of eggs for carlot shipment, and while taking no particular part in the wholesale distribution of eggs in the larger centres, they are wielding a powerful influence for improvement in the producing territory.

Standardization and the application of the standards to the produce moving in domestic channels have had a wonderful effect upon consumption, and, as previously stated, Canada with a population of slightly over nine million people had a per capita consumption in 1926 of 28.1 dozen eggs. In that year Canada's egg production was 262,080,399 dozens, and her imports considerably exceeded her exports. Canada is ahead of any other country in the per capita consumption of eggs, and a great deal of this can be accredited to the standardization of the product. What Canada has done, other countries can do, and with an increased per capita consumption in the United States, Great Britain and European countries there would come a tremendous demand for eggs, and a consequent great boom of the poultry industry.

Marketing Live and Dressed Poultry

Real improvement in the finishing and preparation of poultry for market commenced in Canada about the year 1898. Following a thorough enquiry into methods used in Great Britain, Government demonstration fattening stations were established over a wide area and farms encouraged to finish their poultry properly. Later it was found that with the variation in killing and packing, more satisfactory results could be obtained in preparing quantities for export if the poultry could be assembled at central feeding stations and killed, dressed and packed by experts. There has, therefore, been quite a transition in feeding and fattening from the farm to the central fattening stations operated by the larger packers. This has resulted in the transportation of live poultry and in addition has opened the way for the marketing of poultry over a much longer period of the year.

Previously, practically all surplus poultry was marketed in the months of November and

December. Now, with improved facilities for live poultry shipment, the marketing of poultry is distributed over eight or ten months of the year. Possibly 50% or more of the poultry in the winter months is marketed dressed, but throughout the rest of the year a very large proportion is marketed alive.

Possibly one of the greatest achievements in practical poultry management is for a feeder to take a car of poultry, 3,000 birds or more, and after a run of from one to two thousand miles, deliver it at destination with an increase of 500 to 1,000 pounds in weight. That is one of the problems that has had to be surmounted in shipments from the Prairie Provinces to Eastern Canada, and from the Maritime Provinces to the New England States.

Another problem that has required considerable attention has been the shipment of dressed stock in the summer time, particularly from British Columbia. On the large commercial egg farms of that province, it is the practice to market the cockerels as soon as possible, preferably as small broilers. Such stock is too small and young to stand shipment alive long distances. Poultry dressed and placed in storage is first pre-cooled and placed in a temperature below 0° Fahrenheit, frozen solid, and then held at a temperature of about 10 above. To remove this poultry from cold storage during the summer months, load it in refrigerator cars and deliver it at destination 3,000 miles away and in a condition to be immediately placed in storage again, is one of the problems that has been successfully solved during the two years.

Poultry Standards

Legal standards for dressed poultry not as yet been adopted in Canada. matter has been under consideration for eral years, and while general agreement been reached with regard to the numbe grades and the definititions of grades, culty has been experienced in agreeing on grade names. The discussions that taken place, however, have assisted in adoption of better and more uniform m ods by both private and cooperative e prise.

Some rather remarkable achievement poultry marketing are being achieved operatively, notably by the Manitoba operative Egg and Poultry Marketing sociation. This organization last fall ma ed over 1,000 000 pounds of dressed pou 80% turkeys. In no part of Canada ha cal enterprise in cooperative marketing more effectively developed than in Mani

Standards for live and dressed poultry eventually be adopted in Canada, and confidently expected they will bring to adian poultry a reputation similar to enjoyed by the standardized eggs.

Probably the greatest testimonial to ada's egg standards was given in 1924 by importers of Great Britain. They were a the question "would you like to do away the present Canadian government egg st ards, and go back to the old system of ing on dealers' brand?" The unanin reply was "No".

SECRETARIES OF PROVINCIAL CONGRESS COMMITTEES

Ontario—Dr. F. N. Marcellus, O.A.C., Guelph.
Nova Scotia—J. P. Landry, Agricultural College, Truro.
New Brunswick—F. Leslie Wood, Dept. of Agriculture, Fredericton.
Quebec—L. Crevier, Parliament Bldgs., Quebec.
Prince Edward Island—W. Boulter, Dept. of Agriculture, Charlottetown.
Manitoba—F. B. Hutt, Agricultural College, Winnipeg.
British Columbia—J. R. Terry, Dept. of Agriculture, Victoria.
Saskatchewan—R. K. Baker, University, Saskatoon.
Alberta—J. H. Hare, Dept. of Agriculture, Edmonton.

Canada's National Poultry Registration Programme.

A. G. TAYLOR

Poultry Husbandman, Central Experimental Farm, Ottawa.

Canada has a recognized system under which poultry may be officially registered on he basis of production and standard quality. This has been made possible through the nedium of Egg Laying Contests which have een standardized so that they are all operatd by the Dominion Government.

The Federal Department of Agriculture ealizing the fact that official recognition hould be given to the improved breeding vork being done by the poultrymen of Canda instituted the Egg Laying Contests in 919. Seven egg laying contests were startd in that year, three others were started in 920, and today there are thirteen of these aying contests in Canada. As it was necesary to hold these laying contests on neutral round, the Experimental Farms were chosen s the most suitable place, and since their nception all contests have been operated on overnment owned property.

General

Each province in Canada has at least one ying contest which is provincial in charter and in addition to these provincial consts there is also the Canadian Contest at ttawa which is international.

Each contest, other than the Canadian, is own by the name of the Province in which is held, and where a province has more an one contest the geographic location deles the contest name.

The number of pens to a contest vary to me extent as demands necessitate. Ten rds constitute a pen. Two spare birds e also allowed in each pen to be used as bstitutes should occasion arise. In all re are 5,172 birds in these Government ing contests at the present time.

Objects of Laying Contests

Egg Laying Contests, as conducted in Can, serve a number of very useful purposes. ramount amongst these are first, to stimue interest in the breeding of birds for egg production, and second, to provide a medium of qualification for registration. The last mentioned object has now become the primary purpose of egg laying contests as conducted in Canada.

Breeding for Increased Egg Production

The increase in interest taken in pedigree breeding work for increased egg production and also for larger and more uniform eggs can be attributed very largely to Egg Laying Contests generally, and in this regard Canada ranks at the very front. During the last six years the demand for male birds of pedigree breeding has increased to such an extent that unless something can be told of the bird's breeding he is not wanted at any price. During the same period of time the pedigree breeding and record keeping on poultry farms has almost entirely replaced the old haphazard method with the result that poultry keeping is now recognized as one of the most lucrative departments of the farm.

Fraudulent advertising has been almost entirely eliminated, for most of the leading poultry breeders in Canada have pens entered in the laying contests and it is the production of their birds in the contest that serves as their best advertisement. If a breeder can have a pen of birds laying well in a contest year after year, it is only reasonable to believe that his stock is good and that the practice of breeding is being properly carried out. As the public is supplied with a weekly report of the performance of every bird in the laying contest, the intended purchaser has authentic information for his guidance. Likewise, when advertising, breeders make mention of the performance of their birds in laying contests realizing the significance which information of this kind conveys to the public generally.

That the production per bird has very materially increased since the Canadian National Egg Laying Contests started in 1919

is clearly exemplified by the following figures:

Contest Year	Total Number of birds.	Av. Production per bird.
1919-20	1610	122.5
1920-21	2480	137.0
1921-22	2590	146.3
1922-23	3000	164.3
1923-24	3710	169.6
1924-25	4100	172.2
1925-26	4220	179.5

The increase in production from 1919-20 to 1925-26 is 57, nearly five dozen eggs per bird. Calculated at 40 cents per dozen the increase in production would be worth $1.90 for each hen. It is usually considered that with a production of 122 eggs per bird the profit over feed would be about $1.20 each, which when added to the $1.90 resulting from the increased production would leave a profit per hen of $3.10. It is results similar to those secured in the laying contests that are responsible for the increased interest which has been, and is being taken in poultry keeping during recent years.

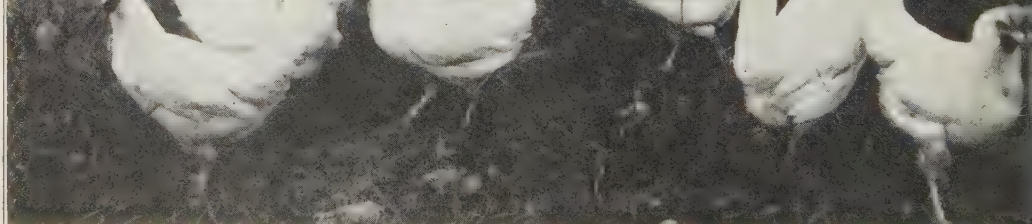
The last mentioned object of the laying contests, to provide a medium of qualification for Registration, is beyond question the most important work which the contests have undertaken. Registration of poultry in Canada, being an entirely new venture in the poultry world, is, so to speak, breaking virgin soil.

Registration

It was the intention of the Department [of] Agriculture in Canada to start registeri[ng] poultry in the autumn of 1920, that being t[he] end of the first year's work known as "Offic[ial] Government Inspection", but due to unf[ore]seen circumstances the work did not get p[ro]perly started until the end of the third ye[ar] 1922. Since that time, all birds which qu[al]ified have been registered and to date, Mar[ch] 31, 1927, there have been registration cer[ti]ficates issued for 3322 birds. Registrati[on] certificates are issued by the Canadian N[a]tional Live Stock Records, Ottawa, whi[ch] places the registration of poultry in Cana[da] on an equal plane with that of live sto[ck].

The Federal Government through the D[e]partment of Agriculture recognizes the f[act] that the seal of Registration is the high[est] mark of quality that can be given, and bei[ng] such, have carefully guarded the chann[els] through which this mark of honour may [be] obtained. Females can only be register[ed] providing they have been entered in one [of] the Canadian National Egg Laying Conte[sts] and have then qualified for this high ma[rk] of distinction. No female bird can be re[g]istered on the basis of heredity alone a[nd] no bird can be registered from any oth[er] source whatever.

The only birds which are admitted to t[he] laying contests are those of breeds of reco[g]nized standing, typical of the breed th[ey] represent, free from standard disqualifi[ca]



Winning Pen, British Columbia Egg Laying Contest, 1924-25.
Owned by J. H. Mufford & Son, Milner, B.C.
Total Eggs—2,683.

tions, free from disease, and from closely inspected flocks. The birds must be well developed and show outward signs of physical fitness.

The production requirement of each and every bird is that she lays 200 eggs or more in the contest year (52 weeks). These eggs must average at least 24 ounces to the dozen, except during the first four weeks. No eggs which weigh less than 20 ounces to the dozen are recognized at any time throughout the year and all soft shelled or malformed eggs are disregarded. All birds laying eggs not characteristic of the breed so far as color of shell is concerned are disqualified. It can be seen from what has been said that only he very best birds can qualify for registraion.

All birds which qualify for registration re marked with permanent tattoo marks in he webs of the wings before leaving the conest in which they qualify. These marks re made up of a series of letters known as reeders marks and year letters and also of umbers which designate the individual bird. here are no duplicate markings so that each ird can be individually identified during the emainder of its life by these permanent ttoo marks.

Registration certificates are issued for all rds which qualify. This certificate bears e seal of the Canadian Department of Agrilture, also the name and address of the own- and breeder, date of birth, name of bird, x, breed and variety, sire and dam, regisation number, chick band and wing label mbers, tattoo marks, number of eggs laid d also weight of eggs in ounces per dozen. formation of this kind is of great value the breeder and due to the fact that it is thentic greatly enhances the value of the d which has been registered.

Registration work with poultry in Canada s not end with the marking and recording these individual birds. Under our regision policy such birds are inspected on owner's plant the following spring and ted to approved or registered male birds. registered females are trapnested and all s recorded on suitable forms. Chicks are ched in pedigree trays and banded, first the leg, and later on the wing, with spec- bands which when sealed on the wings at three weeks of age become a permanent identification mark.

When these chicks are developed in the autumn the inspector goes over them carefully and passes only those which possess good constitution and are free from disqualification. They are then labelled with steel wing labels and are known as "second generation" birds. Cockerels from this mating are disregarded on the ground that the mating may not have been satisfactory.

These "second generation" pullets are then sent to an egg laying contest and must qualify under the same regulations as their dams qualified under before they can be registered. Once they are qualified and registered they are then known as "second generation registered females" and it is from females of this kind that those of subsequent generations which have in their turn qualified and have been registered that registered cockerels may be produced. The males to which these second generation registered females are mated must pass a rigid inspection and wherever possible males which have previously been tested so far as the fecundity of their daughters is concerned are used in this important mating.

It can be seen therefore that the "Registered male" is the zenith of poultry registration work. He is the son of at least two generations of registered females and of carefully selected males for at least two generations, and as he is never inspected or passed until he is at least six months old nothing but males possessing physical fitness, good breed characteristics, and free from standard disqualifications ever qualify to be registered males.

Once registered males are available they will be used in all registered matings, but as the work of registration in poultry is entirely new, the door through which registration may be secured must be left open in much the same way as was practised in other live stock.

It can be seen, then, that the registration of poultry in Canada is not based on ancestry alone, but primarily on production quality. In addition birds must possess those other desirable attributes, namely, breed character, constitutional vigour, and freeness from standard disqualifications.

The Canadian Record of Performance for Poultry.

R. W. ZAVITZ

Supervisor, R.O.P. for Poultry, Dominion Live Stock Branch, Ottawa, Ont.

"Please send me the R.O.P. report for 1926. Through the one you sent last year I obtained stock which lays and looks remarkably well. I want to get two male birds this year but will not do so until I have the R.O.P. report for guidance".

The above extract from a letter received at the office in Ottawa of the Record of Performance for poultry, is typical of many that are received each year. They are written by people who know that R.O.P. stock is good stock, carrying the certificate of the Canadian Government. They know that it is vigorous, true to breed-type and colour, and of high productiveness, and that it is bred and sold by men whose honesty and accuracy in recording, breeding and pedigree work have withstood rigorous and repeated inspection. Once this bond of confidence between breeder and buyer has been firmly established, the sale of stock at home and abroad follows in increasing volume and at good prices. This is precisely what the Record of Performance policy has done for Canadian poultry.

Record of Performance is now in its eighth year. Its history and development form one of the most humanly interesting stories to be found in any branch of poultry work.

Back in 1919 the poultry industry was undergoing a great change. The breeding of poultry for eggs was having a boom, as compared with the "fancy" or exhibition side of the business. In their desire to increase the production, or numbers of eggs laid by their birds, many breeders were sacrificing egg-size as well as breed-type and colour. Some breeders were making absurd claims in regard to production and the public was often at a loss to know where to go for stock of real merit. Officials of the Department of Agriculture saw that unless steps were taken to stabilize the situation, serious results would follow.

There were also economic factors which made it imperative that production costs be lowered. Several countries which before t world war had been large exporters of egg were again making their presence felt. Com petition in the world markets was becomin very keen, and it appeared that the count producing quality eggs at the lowest co would win out. The answer seemed to increased production per bird—more eg per pound of food fed.

Shortly before this a great deal of wo had been done, chiefly in the United State along the line of estimating production fro physical changes in the bird. It had be proven that enough was known of the e ternal indications of production to enab reasonably accurate estimates of past and pr sent production to be made, provided the fa tors of breeding, feeding, housing, etc., we known.

It remained for W. A. Brown, Chief the Poultry Division, Live Stock Branc Dominion Department of Agriculture, to ha the vision and the ability to combine th newer knowledge and the needs of the i dustry in the form of a national policy f the official certification of private records a system of periodic inspection, known Record of Performance. No greater tribu could be paid to the care and thoroughne with which Mr. Brown framed the R.O. policy, than to say that during nearly eig years of operation and a great increase in t volume of the work, only very minor chang have had to be made in the regulations. must be borne in mind that this was a ve ture along entirely new and untried lines.

Briefly, Record of Performance consis of the official inspection of privately tra nested flocks of pure-bred poultry on t breeders' own plants, and the subsequent ce tification of the production recorded. T test lasts for a year, each bird's record-peri starting with the first egg laid in a trapne provided it is between August 1st and Dece ber 31st. The birds must be vigorous, fr from contagious disease and standard d

qualifications, and of reasonably good breed type and colour. The eggs must average at least two ounces each in weight. Inspections are unannounced, at irregular intervals of from four to seven weeks, and of one to three days' duration. During his stay the Inspector has entire charge of the birds as regards trapnesting, weighing the eggs, etc.

The scheme appealed to many breeders, particularly those already engaged in or contemplating systematic pedigree work on their own plants. It stressed those factors which have meant the most in the development of the live stock industry—the capitalization of individual effort in the solution of breeding problems, and the development of high producing stock by individuals on their own farms, in a practical, economic way. In other words, the policy was designed to bring to the fore individual ability and enterprise in poultry breeding, and to focus them on common economic objectives, in a national way.

It was quite natural that in its early stages such a new and revolutionary undertaking would come in for its share of unfavourable criticism. It was freely predicted that no system of inspection and supervision, be it ever so strict, could verify and guarantee trapnest records made by breeders on their own plants. With such criticism those in charge of the work took no issue, preferring to let the results speak for themselves. They knew that the foundation was broad and strong and that it required only proper administration to build up a policy that would be sound in principle, practical in application and accurate in its verification of the records. The proof of this is the growth of the work, world-wide acceptance of the records and demand for the stock.

The administration of the R.O.P. policy, as regards checking the records, is not such a difficult matter as it might at first appear to be. The vast majority of breeders are honest and have too much at stake to send in false reports. The Inspectors are highly trained in estimating production from the birds' handling qualities, etc., and are also expert in sizing up the man in charge of the birds and telling whether it is reasonable to expect records such as are being reported, taking into consideration breeding, condition, feeding, housing and attention. It remains for the Supervisor to correlate the available information, examine the records, and pick out any doubtful looking entries. These are then subjected to the most careful examination, mathematical checks of various sorts are applied to the records, further and specific information is obtained, with the result that it is not hard to tell whether or not the records are authentic. It is necessary to concentrate in this way on only a small number of breeders each year.

There is now little or no tendency on the part of any breeders to falsify their records. They know that the check on the production is close and efficient and that to be dropped from the record would seriously injure their business. Further, the breeders realize that their records must be accurate if they are to have the information necessary to carry on their own breeding work.

After over seven years of successful operation, Record of Performance is today prepared to refute any claims that the records made under its supervision are not accurate and reliable. The whole system has been most thoroughly examined at different times by some of the foremost poultrymen, statisticians, journalists and others, and has invariably been pronounced accurate, reliable and above all, useful.

Of its field of usefulness there has never been any doubt. Had it done nothing more than check wild and extravagant advertising and made known the best sources of breeding stock, it would have justified its existence. But it has gone further in encouraging the breeders to breed for vigour, egg-size, standard breed qualities, etc., and the general standard of R.O.P. stock is today much above what it was a few years ago.

Through the exchange of ideas during the visits of the Inspectors, the ideals and methods of the breeders have been greatly advanced, and herein lies the greatest good of the policy, as the excellence of the stock can only be the measure of the wisdom, skill and industry of those producing it.

The improvement in Canadian flocks is already apparent, the average production per hen having risen six eggs in the past four years, after remaining stationary for a long period. In 1926 there were thirty-four million hens in the country and the average price of eggs was 36 cents per dozen; the increased production brought in $6,120,000 additional revenue.

The primary object of Record of Performance is the improvement of Canadian poul-

try as regards vigor, production, egg-size and standard breed characteristics. In order to do this, the stock bred and tested under R.O.P. must reach the great mass of poultry on the general farms of the country. This can best and most quickly be brought about through the distribution of male birds. To this end a supplementary policy, known as "Cockerel Approval", was devised and put in effect. It provides for the mating of R.O.P. tested and certified females with selected males, usually themselves of R.O.P. stock. The chicks from these matings are pedigreed under a standardized system, each step of which is carefully checked by the Inspectors. When they are six months old the cockerels from the matings are given a rigid culling by the Inspectors and those which pass inspection are banded with official sealed bands.

This cockerel approval work is carried on by the Record of Performance Breeders' Associations in the various provinces. The Department, through the Inspectors, approves the matings, checks the pedigree work and inspects the cockerels, on behalf of the Associations.

In this way the various links in the Record of Performance system have been built up and now form a chain leading from the highly specialized breeding plants where R.O.P. work is carried on, through the R.O.P. Breeders' Associations, to the farm flocks of this country, and to many other countries as well.

During the first seven years of R.O.P. work a total of 94,419 birds have been banded and tested. Of these, 26,551 birds qualified for R.O.P. standard certificates (150 eggs) and 7,698 qualified for R.O.P. Advanced certificates (225 eggs). Thus a total of 34,249 birds have been granted official government certificates covering their production, egg-weight, standard breed qualities, etc. This mass of tested and certified stock, distributed in every province of the Dominion, is a national asset possessed by no other country.

One factor contributing in no small degree to the success enjoyed by R.O.P. breeders has been the activity of the Provincial R.O.P. Breeders' Association in seeking and developing markets for R.O.P. stock. There are now eight of these organizations and it is noticeable that the success of the breeders in any province is in direct ratio to the activity of the Association in that province. By pooling their resources in these Associations the breeders have been able to carr on advertising campaigns and make sale quite beyond their ability in their privat capacity. The British Columbia Associatio has been particularly active in securing fo eign business and shipments of R.O.P. stoc have been made to practically every count where poultry is of prime economic impor ance, total sales of over $30,000 being mad last year, in addition to those made private by the members. In this export trade breeding stock the government certificate h been found to be a most potent factor in e tablishing confidence between buyer an seller.

Up to the past few years very few Ca adian breeders sold stock abroad and larg importations of breeding stock were ma each year. The tide is turning; poultrym the world over realize more and more ea year that there is a class of stock bred Canada, under Government supervision an guarantee, which they want and which available in no other country. Northe grown, hardy and vigorous to withstand an produce heavily during Canadian winters, o ficially certified as to production, breed ty and health, R.O.P. stock is quite capable holding its own with any in the world.

The demand for R.O.P. stock is not ha to explain. Prospective buyers know that is bred and tested on commercial plants u der sound economic conditions. The plan from which it comes are sanitary and t birds themselves healthy and vigorous. Th have passed rigid tests and carry the certi cate of the Canadian government to this fect. Further, a breeder whose metho honesty and stock have received approval R.O.P., may be trusted to treat his custome fairly and honestly.

The poultry industry in Canada has a gre future, the possibilities of which are on now unfolding. Her rigorous northern c mate is a natural bird habitat and produ birds abounding in vigor and ability to sta up under heavy and continued producti and to resist disease. The foundation sto is here, second to none in the world. Cana was the first, and is still the only country establish and operate a national policy the testing, improvement and certification breeding stock. Last, and most important all, the breeding operations are in the han of men who have definite objectives a ideals, and are moving toward them in national, organized, economic way.

Canada's Provincial Poultry Activities.

The following pages have been prepared by various poultry authorities in the different provinces of Canada. As 1927 is the Diamond Jubilee of Confederation the provinces are named in the order in which they entered Confederation, which is as follows;—Ontario, 1867; Nova Scotia, 1867; New Brunswick, 1867; Manitoba, 1870; British Columbia, 1871; Saskatchewan, 1905. No contribution has been received from Prince Edward Island.

The article from British Columbia, on page 340, deals with the ten birds which recently established a world s record for egg production, rather than with the poultry activities of that province.

The activities of the province of Quebec, which entered Confederation in 1867, have been written in the French language and for that reason are being published in the French section of this issue. They will be found on page 359.—EDITOR.

Ontario

W. R. GRAHAM

Professor of Poultry Husbandry, Ontario Agricultural College, Guelph.

The statistics of the Province for the year 925 give the total poultry population as 7,778,581, which is an increase over 1924 f almost 1,000,000. These are the figures r the poultry on farms, and do not include e poultry in towns, cities, and villages. In und figures there are 480,000 turkeys, 55,000 geese and 558,000 ducks.

The increasing interest in poultry on the rm is probably due to the facts that poul-y has been profitable, both from the egg oduction and meat production point of ew; and, moreover, the use of incubators d coal burning brooders has made it pos-ole for many farmers to carry several hund-d hens, where they formerly carried about venty-five or a hundred.

The number of hatcheries within the prov-ce is increasing every year, and these in rn might be divided into three classes. ere are a large number of successful farm cks where the owner has one or more small np incubators and this operator runs the chines for several hatches, selling many the chicks to his neighbors. There is also specialized poultry farmer, who in most tances has a mammoth incubator and sells y old chicks and eight week old pullets. ny of these operators have birds in R.O.P. addition to the two mentioned above, there the commercial hatchery, and these are reasing annually. Eggs for the commercial hatcheries come largely from selected farm flocks. The hatchery business has been reasonably profitable during recent years, and the factor that influences the price of chicks is largely a question of the hatching power of the eggs set.

In reference to the marketing of eggs, many of the farmers have good local markets, and the markets in general in Ontario are very good. In discussing ordinary marketing, there are three particular marketing organizations that are worthy of special mention. There is the egg pool, as operated by the United Farmers of Ontario (this organization also handles poultry). Then there is the Woodstock Co-operative organization which markets eggs, poultry and day old chicks. On Manitoulin Island there is a special marketing organization among the turkey growers. There are numerous other smaller organizations, more or less similar to those mentioned above.

With special reference to the government activities within the province, it is difficult to outline all of these in a brief space. Particular mention might be made of the association known as the Confederation of Local Poultry Associations, which looks after the interests of all the local poultry associations within the Province. These take care, to a large degree, of the extension work and poultry shows of the towns and cities. The special poultry work done in each county is done

in co-operation with and under the direction of the Agricultural Representative for that county. Or in other words, there is no poultry work done in a county without the cooperation of the Agricultural Representative. The activities in these counties consist of the conducting of special poultry short courses of three or four days duration, at which the attendance usually runs well over a hundred and sometimes nearer two hundred. The Agricultural Representative directs the culling work, and each year we are conducting more culling schools, or training local men to cull, and consequently giving less culling demonstrations. Each county has a number of breeding stations; these stations are selected by the Agricultural Representative, the flocks are approved, culled and blood tested by a man from the Poultry Department of the Ontario Agricultural College. Each flock is inspected at least once a year by the college, and several times by the Agricultural Representative. Every year there are some flocks found unsatisfactory and new ones are added. These flocks supply the eggs for hatching to the rural school children; the males for the flocks are hatched and grown at the college from pedigreed, high producing ancestors. It has been felt that if the males were carefully selected, that known ancestry was behind them, that a thorough culling campaign with the hens would, under the circumstances, make a reasonable breeding proposition. To sum up this activity, there are roughly 15,425 hens in the breeding stations. There are 211 flocks, and in round figures it takes between 800 and 1,000 pedigreed cockerels to supply the breeding stations.

Control of diseases and the study of disease, together with the research work, is done by the Ontario Veterinary College, the Poultry Department of the College co-operating in every way possible.

Experimental and research work might be divided into three main activities. We are vitally interested in the problems of the hatching power of eggs, as influenced by nutrition and genetics. It will be readily understood that both of these are serious factors. An attempt to produce reasonably high laying hens that have a fair sized egg, and hatching power, is the main object of the work in genetics. For years we have been interested in the problems of brooding and the question of the nutrition of the chicks, soil contamination, and the rearing of chick indoors.

We have recently established a Turkey Ex perimental Farm in Norfolk County. In th year 1925, we hatched and reared a numbe of turkeys in confinement; that is to say th turkey eggs were hatched in an incubato the poults raised in a brooder house with cement floor, and the young turkeys wer allowed out of doors on a cement walk, bu were never allowed on the ground. The wor at the turkey farm is just nicely getting un der way, and we will probably set in th neighborhood of 1,000 to 1,500 eggs ther this year.

In regard to the teaching activities, a on month's short course is conducted in th month of January each year, besides regula lecture work with the Associate Class, an also with the Degree Classes during the en tire four years. We have never develope a Poultry Option. Our opinion has bee that the general Agricultural Option cover ing all lines of live stock would fit a ma who is specially interested in poultry, s that he could carry on reasonably well. I addition to these there are the numerous shor courses in extension work. Special cour ses are given to school teachers during th summer.

There are a large number of poultr breeders in Ontario who are trap nestin their hens and pedigreeing their chicken Some of these breeders have birds in Canad ian Laying Contests, and a few in the Amer can contests. At present there are abou fifty-five members of the R.O.P. Association Prof. F. N. Marcellus, of the Poultry De partment, is acting as secretary for the R.O.P Breeders Association of Ontario. This is a active organization and the breeders ar making considerable progress.

It may be of some interest to add a fe short notes in reference to the poultry plan at the college. There is a main building o two storeys, 110 x 60 ft. There is housin accommodation for more than two thousan laying and breeding hens. The departmen is well equipped with incubators, both larg and small. The question of rearing chicken is interesting. The department has a mai brooder house that is equipped with cemen floors and outside cement runs. In the yea 1926 the department hatched and broode more than 10,000 chicks. The amount o

land devoted to the Poultry Department is not large, but the department has a working arangement with the Farm Department and the Department of Horticulture, which admits of the use of about twenty acres of land for rearing chicks. The arrangement permits the department to move the chick ranges from year to year. In one instance, the department rears chickens on alternate years, and in the other about once in four years.

In addition to the poultry activities at the Agricultural College, there is a well equipped poultry department at the Kemptville Agricultural School, which is doing splendid breeding work, and is supplying some of the cockerels and doing some of the extension work in connection with the Agricultural Representative force. There is also some poultry kept at some of the other branch farms.

Nova Scotia

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There are, in the Province of Nova Scotia, bout 47,000 farms, on which are kept 993,-00 hens and chickens. There are, also on ractically the same farms, about 6,156 ucks, 8,873 geese and 6,038 turkeys. The alue of eggs produced in the Province is 2,650,805. Estimating the consumption at wenty-seven dozen per capita Nova Scotia onsumes about 14,143,599 dozens of eggs er annum and as our production is only bout 5,000,000 dozen per annum we have home market for approximately 9,502,915 ozen more eggs than we produce.

The average of fowls kept is less than 25 ens and chickens to each farm. The attitude f the average farmer towards his poultry is ne of indifference and one may conclude at the size of the flock kept on the average rm is a fair indication of the interest the wner has in the production of poultry and gs. On farms where flocks are larger the ccess is usually greater and much better tention is given to the poultry kept. In any sections of Nova Scotia the ordinary rm flock is maintained for the convenience the home and any surplus eggs have hereore been disposed of at the country stores. e disposition of eggs and poultry as a cash op has not been thought worth while and g and poultry marketing organizations, en organized, have considerable difficulty getting volume, lacking which it is almost possible to operate successfully.

Previous to the year 1915 very few comrcial flocks were kept in this Province. The velopment of commercial hatcheries in the New England States demonstrated to a number of small poultry farms the value of large commercial flocks from a profitable viewpoint. In 1915 a number of poultrymen clubbed together and ordered the first importation of day old chickens from the New England hatcheries. These were received in excellent condition and demonstrated that the stock from which they had come had abundance of vigor and strength. During following years importations increased and in 1919 assistance was given, as a Departmental policy, to import day old chickens. The number imported by assistance from the Department was as follows:—

1919 — 7000
1920 — 10,000
1921 — 14,000

In 1921 Department assistance was discontinued and private breeders and commercial men imported what chickens they required at their own expense.

The development of commercial plants has been very satisfactory and at the present time plants of over 2,000 laying hens are to be found in the Province.

Egg Circles have been in operation during the past twelve years. They have, however, been unable to attain a marked success as has been done by similar organizations in Prince Edward Island—chiefly due to the fact that members find a ready market for their product at home or at the nearest consuming centres for what eggs they produce and are inclined to follow the line of least resistance by marketing at the nearby centres.

This attitude frequently results in Egg Circles losing a large proportion of their membership during the greater part of each year. Production has increased and in recent years Egg Circles have been established in about twenty-three different sections of the Province. In July of last year an organization meeting was held for the purpose of uniting the different Egg Circles into a Central Organization whereby marketing of the product could be controlled. This Organization has recently amalgamated with a similar organization in the Province of New Brunswick and is under one Manager.

In the year 1913 the Provincial Government passed an Act known as "The Act for Encouraging Poultry Breeding" by which poultrymen and farmers could organize County Poultry Clubs for the purpose of engaging in any undertaking for the promotion of poultry production, breeding or exhibiting their poultry. Ten of these Clubs were organized and held poultry shows in as many counties but recently the tendency has been to group the Counties and hold District Poultry Shows. These Poultry Clubs solicit trophies, silver cups, special prizes, etc., which are offered for competition and this results in keen competition among the breeders in the different classes. Much improvement can be traced to these Poultry Club Shows.

Private enterprise has become interested in the development of the industry. Several hatcheries have been established in different parts of the Province.

At one station in the Province 12,000 day old chickens were landed for distribution among the poultrymen and farmers in that neighborhood last year. Commercial poultry keeping is, therefore, making rapid progress along a definite line in Nova Scotia. It is noticeable, however, that the average farmer is not taking up with poultry production to the same extent as the specialized poultry farmer. In explanation of this fact it has been offered as an excuse by many farmers that they do not deem it profitable to purchase feed for their poultry and that they are not producing sufficient quantity of grain to warrant the increase in numbers of fowls in their flocks of poultry.

The Department of Agriculture has established a Poultry Division in connection with the Agricultural College. Instruction is given the students attending the College in incubation, rearing and marketing of poultry, judging of breeds, etc. Lectures and courses are given in poultry husbandry at the Short Courses established in the different centres of the Province.

An R.O.P. Association has been formed in connection with the work carried on by the Nova Scotia Poultry Association and the membership has increased each year. Laying contests are conducted at the Federal Experimental Farms at Nappan and Kentville.

The Dominion Department of Agriculture, Live Stock Branch, has employed a Poultry Promoter, resident in the Province, who has been carrying on, for a number of years, the organization of Egg Circles, Marketing Associations and general poultry development work.

More interest has been taken and the outlook seems favorable for the development of poultry production in Nova Scotia. Culled hens have been shipped in carload lots and recently a warehouse has been opened for egg grading and shipments at Truro.

It is likely that Nova Scotia will, in the course of a few years, be self-sustaining as far as poultry production is concerned and we are endeavouring to live up to a motto "Produce what we Consume".

New Brunswick

F. LESLIE WOOD

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Poultry keeping as a commercial proposition is still in its infancy in New Brunswick. There are few commercial flocks but the number is increasing and the size of flocks kept on farms is also growing. In fact the poultry industry of this province has shown a greater and more consistent growth over a period of years than any other branch of

ive stock. The best statistics available are hose published from Ottawa in the Monthly Bulletin of Agricultural Statistics. If several ears' numbers of these bulletins are studied marked falling off in the poultry population vill be noted since 1922 but this is due to new system in collecting data rather than decline in numbers of fowls kept. Since hat date statistics are compiled only from eports of farms of over fifty acres which aturally rules out much of the poultry population even including most of the commeral farms.

The year 1926 was a poor one from which judge the province's poultry industry. It as one of the poorest hatching seasons on ecord and while increases in size of flocks ere quite generally planned, statistics show temporary decrease in numbers. The 1926 gures are available and show that 24,434 rkeys, 17,354 geese, 6,380 ducks and 806,-3 other fowls were found on New Brunsck farms (over fifty acres in size). They rther show that 604,855 egg-producing hens id 3,931,753 dozen eggs valued at $1,100,-1.00.

The province only produces about half ough eggs to feed itself and it is estimated at 4 200,000 dozens are imported annually. ns are kept quite generally over the whole ovince on farms but in small flocks only. rkey raising is confined mostly to restricted eas, the largest being Bolsford parish of estmoreland County, which markets many s of dressed turkeys co-operatively each ır.

Egg circles for the co-operative marketing eggs have been in operation in the prove for a number of years but it was not il 1925 that an attempt was made to fedte these and to have marketing done under central assembling, grading and selling ncy. The New Brunswick Poultry Exnge had its birth early in that year and organization of egg circles in country nts has since been pushed by both provin- and Dominion Department of Agricule officials. This marketing organization shed its first year's business with a surs in spite of small volume and was able have more than double its volume of eggs dled in 1926 over the previous year and a 20% increase in poultry handled. ly in the present year this organization a more recently organized Exchange in Nova Scotia have amalgamated and have applied for a Federal Charter under the name of The Maritime Co-operative Egg and Poultry Exchange. The volume of business done so far is considerably in advance of the amount handled up to this date last year.

Extension work in New Brunswick is largely carried on with the Provincial Department of Agriculture and Dominion Live Stock Branch co-operating. Three distinct policies have been or are now in operation under the joint management of these two agencies.

The cockerel distribution policy has been in operation for four years and during that time approximately 2,000 selected pure-bred Barred Plymouth Rock cockerels of high laying strains have been distributed to farmers' flocks under a bonus system which gave them to the farmer at almost meat price. The policy has been responsible for a decided improvement in the uniformity of farm flocks, an increase in size and egg laying qualities and an appreciation on the part of the farmers for better breeding male birds. It has to a considerable extent created a demand for pedigreed birds and for 1926 the policy has been changed so that bonus paid will be only for males from registered and R.O.P. hens.

The flock approval policy is in its first year of operation and definite results cannot be quoted. Forty-five poultry keepers have entered and from the reports they give of their flocks much valuable data concerning production costs and profits should be accumulated in a few years time. The policy is also expected to furnish enough flocks, the breeding of which is under government supervision, to provide a good supply of hatching eggs, etc.

The present poultry club policy is an entirely new venture in 1926 and at the time of writing only preliminary field work has been done. By this policy it is hoped to increase the production of poultry, further standardize New Brunswick poultry and give the younger people a grounding in poultry culling and judging that will enable them to select poultry breeding stock intelligently.

For a number of years eggs have been annually distributed through schools to scholars. Each pupil is allotted twelve eggs and there must be at least six pupils in one school wanting them before eggs will be sent. Where school fairs are held special awards are made for chicks hatched from these eggs.

The number of eggs distributed in this manner frequently reaches 1,000 dozens per year and has resulted in a general improvement of the poultry in the districts to which eggs have been sent.

New Brunswick has no college of agriculture but its Department of Agriculture operates a general short course in Agriculture for young men each autumn. Poultry has been allotted generous space on the curriculum and in the 25 to 30 hours available for this subject the students get a general grounding in poultry judging for egg production, housing, feeding, breeding, marketing, incubating and brooding. Poultry short courses are held from time to time in different places, largely from sections requesting them.

Practically the only experimental or investigational work done in the province is carried on at the Dominion Experimental Station at Fredericton. Provincial Department of Agriculture and Dominion Live Stock poultry men spend their entire time on instructional or extension work.

The Poultry Producers of New Brunswick Incorporated is New Brunswick's Provincial Poultry Association. It is an association of comparatively recent origin but has had a steady growth of membership and has been instrumental in shaping the poultry policies of the province. Only a small percentage of its members are actively engaged in Record of Performance work but the organization acts as an R. O. P. Association for these members. An annual sales catalog is p lished. The organization also handles p trymen's supplies for the benefit of its m bers and is doing a rapidly growing busi in this line.

The first egg laying contest in New Br wick was held at the Fredericton Experim tal Station in 1920-21 and contests have b held annually since. In the latest con (1925-1926) New Brunswick led all cont east of the Rockies for average egg pro tion. The average production since the ception of the contest has shown consis increase as shown by the following figure

1921 — 152.13 eggs
1922 — 139.43 "
1923 — 162.25 "
1924 — 165. "
1925 — 164.7 "
1926 — 183.38 " and 185.58 poi

Special poultry shows do not receive same attention they did several years ago. have, however, four or five annual exhibiti in the province that include generous pr for exhibition, utility and R.O.P. poul The number of these larger exhibitions increased and this is probably the cause the decline of exclusive poultry shows. Moncton Poultry Association is the only which has held shows in recent years. poultry departments of the larger exhibit and even the smaller fairs are well filled high quality stock, particularly in the b to-lay classes.

Manitoba

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With the growing tendency toward mixed farming in Manitoba, the poultry industry has steadily forged ahead. In 1926 eggs and market poultry returned to farmers of the province over five and three quarter millions of dollars. In that year the value of eggs produced was $3,995,250.00 and the value of market poultry $1,758,000.

Manitoba's 51,110 farms have 3,414,714 hens, an average per farm of 66 hens. Data obtained in culling over 3,000 farm flocks show that 58% of the purebred flocks Barred Rocks, 18% are White Wyand and 8% are White Leghorns. Rhode Isl Reds and Buff Orpingtons are next in po larity.

Turkeys have proven a most profit side line in recent years. As a result, turkey population has increased fifty per in the last 4 years and in 1926 stood at 3 875. Ducks and geese are less popu Some of the Hutterite colonies, howe

nake a specialty of geese and as high as 1500 birds are raised at some colonies each ear.

There are very few commercial poultry lants in Manitoba, although some farmers ave specialized to a degree where half or nore of their income comes from the hens. However, at St. Norbert, ten miles south of Winnipeg, the Trappist Fathers have wintered his year approximately 6,000 White Leghorns. So far as the writer is aware, this the largest commercial poultry plant in anada.

One evidence of the increasing interest in oultry is the growing demand for baby nicks. In the City of Winnipeg there are ve hatcheries, the largest having a capacity 40,000 eggs. Besides these, there are sev-al other poultrymen in other parts of the ovince selling baby chicks or doing custom tching. Hatchery operators all report a emendous rush of orders this spring.

One of the factors contributing to the in-easing interest in poultry in Manitoba has en the development of the Manitoba Poul- Marketing Association. This organization irted business in 1922 by marketing five rs of dressed poultry from 9 shipping ints. The steady progress made since then shown in the following data from the mar-ing report of the company:

	1922	1923	1924	1925	1926
essed Poultry					
o. of shipping points	9	24	32	54	78
o. of cars	5	30	19	40	55
ll Hens (live)					
o. of cars		3	2	9	7
gs					
o. of grading stations			1	3	5
o. of cars			11	48	103

n former years the egg grading stations e remained open only for five months in spring and summer, so the figures given ve for eggs represent business done only the months of heavy production. This ng a sixth grading station has been open-n Winnipeg and it is planned to keep this n throughout the year.

ecause of its low overhead expenditure the use of volunteer labor in shipping dressed poultry the Cooperative Associa- has been able to make excellent returns to its members. Last year shippers received 38c per lb. net for Special turkeys and 35c for No. Ones. The average price (net to producers) of eggs was 25½c for Extras and 23½c for Firsts. No. 1 cull hens netted 14c per lb. and No. 2 hens 12c.

The bulk of the dressed poultry handled by the Co-operative is turkeys. Demonstrations in killing, plucking and dressing are given at each shipping point some time before shipping. The uniformity thus started is further ensured by careful grading and packing on shipping day. Each farmer sees his poultry graded and learns how to improve his product in the future.

At the Manitoba Agricultural College, the Department of Poultry Husbandry provides instruction in its field for degree, diploma and short course students. It occupies 17 acres of land and has excellent buildings with a capacity for 1800 hens, also brooder capacity for several thousand chicks. The department has the distinction of being the first in Canada to offer short courses by radio. Professor M. C. Herner has been head of the department since its inception in 1911.

Under the direction of Mr. A. C. McCulloch of the Dominion Live Stock Branch, 58 Approved Flocks have been established in various parts of the province. These flocks constitute a valuable source of supply of good bred-to-lay stock, principally of Barred Rocks. By them over 60,000 hatching eggs were distributed last year. The Live Stock Branch also supplies and trains men for grading the dressed poultry marketed by the Co-operative Association.

The Extension Service of the Provincial Department of Agriculture supplies annually a culling service which in the last three years has been utilized by over 3,000 farms. The cullers demonstrate their methods, discuss housing and other poultry problems, examine for disease and gather valuable data on farm poultry conditions. The cull hens are shipped out in live poultry cars by the Cooperative Association whose local representatives make the necessary arrangements for culling. The Extension Service secures monthly records of the farm poultry business from 22 Demonstration Flocks. It also operates annually a travelling poultry car and arranges various poultry meetings and demonstrations.

Fourteen poultrymen are engaged in Record of Performance work and all are members of a thriving R.O.P. Association which issues annually a very attractive catalogue. A Turkey Breeders' Association has recently been formed with the object of improving the stock in the province and providing recognized sources of good stock.

At the Brandon Experimental Farm is held the Manitoba Laying Contest. The Brandon farm has an excellent flock of Barred Rocks and the Morden Experimental farm has both Rocks and Rhode Island Reds. Both static are doing some experimental work.

Increased interest on the part of many er while staunch wheat growers, together wi the tremendous demand for baby chicks a hatching eggs indicate that poultry is pla ing a very important part in the trend towa mixed farming. An abundance of cheap fee long days in the growing season, dry clima and a large city market are all factors whi have rightly made farm poultry recogniz as a most profitable side line in Manitoba

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British Columbia

A Few Facts About Ten Hens that Made An Official World's Record for Number of Eggs Laid.

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People in the mass and as individuals are always interested in an individual or event that breaks all previous records. This is one of the reasons for the wide-spread interest taken in Hen No. F 326 (No. 6) and her pen sisters in the team of ten birds entered by the University of British Columbia in the sixth B. C. Egg Laying Contest held at the Dominion Experimental Farm, Agassiz, B.C., from November 1, 1925 to October 30, 1926. The performance of F326 marks a new advance in the number of eggs laid by an individual hen in a year of 365 days, hence has proved of interest to the general public and particularly to poultry breeders. This being so, the performance of this hen, and the reasons for that performance, are of sufficient interest, both theoretical and practical, to warrant the publication of such detailed information as is available.

The ration fed and the range in outside temperatures are usually recognized as important factors affecting the number of eggs laid by the domestic hen. The ration of scratch grain and mash fed at Agassiz was composed of the usual ingredients liberally supplemented with milk and greens. These supplements undoubtedly contributed much to the results secured. The particularly mild climatic conditions prevailing at Agassiz for the duration of the contest furnished exc tionally favourable temperature conditio but since no use was made of artificial lig the birds may have been handicapped, d ing the fall and winter months, by the lo nights and consequent lack of sufficient ho of day light.

Breeding is generally conceded to be supreme importance in determining the ab ity of a hen to lay eggs. It is, therefore, teresting to compare the performance of F3 by months with that of her known female cestors for which detailed records are ava able. Table 1 shows the egg production F326, her mother, two grandmothers, and average monthly production of her four gr grandmothers. It will be noted that b the mother (D250) and maternal gra mother (B3075) laid at a consistently hi rate throughout most of the twelve mont while the paternal grandmother (C292 laid at an exceptionally high rate in Dece ber and January, and in April to Octo inclusive, but rested in February. The fo great grandmothers also laid at a good r through most of the year. Their avera twelve months record was lowered somew by A340 (see Figure 1) whose product for the twelve month period here conside was 187 eggs. Her record for the first 3 consecutive days of laying was 207 eggs.

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Breed:

Pedigree of	Sire No. 810D (6.1 lbs.)	Sire No. 8517 (6.0 lbs.)	Sire No. 6371 (5.1 lbs.) Dam No. B3020 (4.6 lbs.) 1st year 301 (1.96 oz.) eggs
Wing Band 516E		Dam No. C2924 (4.0 lbs.) 1st year 284 (1.92 oz.) eggs 2nd year 202 eggs.	Sire No. 4362 Dam No. B467 (3.8 lbs.) 1st year 258 (1.94 oz.) eggs.
Leg Band F326 (4.4 lbs.) Nov. 1/25 — Oct. 31/26 — 352 eggs. Av. wt. of egg 1.86 oz.	Dam No. D250 (3.5 lbs.) 1st year 271 (1.98 oz.) eggs 2nd year 188 eggs.	Sire No. 6368	Sire No. 3792 Dam No. B501 (4.0 lbs.) 1st year 268 (2.12 oz.) eggs
Hatched March 25, 1925. Age at 1st egg, 219 days.		Dam No. B3075 (4.0 lbs.) 1st year 256 (2.04 oz.) eggs 2nd year 179 eggs.	Sire No. Dam No. A310 1st year 187 eggs.

Fig. 1. Pedigree of S. C. W. Leghorn Hen No. F326 who made a new World's Record for Domestic Fowl by laying 352 eggs in 365 days.

Table 1.

The Egg Production, by Month, of F326 and Three Generations of Her Ancestors.

	F326	Mother (D250)	Maternal Grandmother (B3075)	Paternal Grandmother (C2924)	Average for Four Great Grandmothers
November	27	23	15	15	19
December	30	23	21	26	17.75
January	30	24	21	28	15.5
February	27	21	19	16	19.5
March	31	25	22	21	21.75
April	30	24	26	26	25
May	31	25	23	28	25.75
June	30	25	22	24	24.5
July	31	24	24	28	25
August	31	25	23	26	23.75
September	29	20	23	24	21
October	25	12	17	22	15
Total	352*	271	256	284	253.50

*The official record of this hen was 351 eggs, 1 egg being diallowed by the contest management because it weighed less than 1.25 ounces, or 20 ounces to the dozen.—Editor.

Table 2.

Average Monthly Egg Production of the Contest Birds and Their Mothers and Grandmothers.

	Contest Pen No. 32, Agassiz 1925-26	Mothers (7 Birds)	Grandmothers (7 Birds)
November	19.6	21.4	13.9
December	26.1	24.0	21.3
January	25.7	23.1	20.6
February	23.4	21.0	13.4
March	26.2	24.0	20.1
April	27.7	22.9	25.0
May	29.2	25.6	24.1
June	27.5	23.4	23.9
July	28.4	22.6	24.7
August	27.9	24.7	22.7
September	23.0	18.7	21.0
October	12.4	8.6	13.6
Total	297.1	260.0	244.3

As was to be expected on account of the high total, F326 laid at an exceptionally high rate in every one of the twelve months. It will be seen that she laid for at least six months without a stop. The actual number of eggs laid consecutively without a day's interruption was 213, laid from March 1st to September 29, 1926, inclusive.

Figure 1 was prepared to show the information, supplementary to that given in Table 1, which is usually considered when selecting hens for breeding purposes at the University of B.C. It will be seen that F326 was comparatively late maturing, since she did not lay until she was 219 days, or approximately seven months old. Like most of her ancestors, F326 is a bird of good size weighing 4.4 pounds. She gained nearly a pound (0.9 lbs.) during the twelve months and, like the other birds, was in excellent condition at the end of the contest which speaks well for the care given the birds by the contest staff. The eggs laid by F326 and her mother (D250) weighed, on the average, 1.86 ounces (52.6 gr.) and 1.98 ounces (56.1 gr.) respectively, and were, therefore, under the two ounce average required for registration. In this connection it may be noted in passing that 31 eggs laid by F326 in the following year from about the first of February to March 15, 1927, weighed on the average 2.07 ounces (58.7 gr.) each.

The average egg production, by months, of the ten 1925-26 Contest birds, including F326, is shown in Table 2. The average egg production of their seven mothers and seven grandmothers (two paternal and five maternal) is also given. The figures for the contest birds include all eggs laid in trap-nests whether they weighed one and two-third

Figure 2.
S.C.W. Leghorn hen No. F 326 as she looked after her record breaking performance of laying 352 eggs in 52 weeks.

ounces or not, but do not include eggs laid on the floor. If eggs laid on the floor were also included, the averages for November, December, May, July, August, September and October would each be increased by a fraction of an egg, which would bring the total number of eggs laid by the ten birds up to 2986 eggs. Of the 2986 eggs, 40 weighed less than one and two-thirds ounces. These 40 eggs were all laid in November, the first month of the contest.

The information given for the contest birds in Table 3 is sent out by the Dominion Experimental Farms to each contestant in a slightly different form. The information for their mothers was secured partly from contest data and partly from the breeding records at the University of B.C.

It is interesting to note that eight out of the ten 1925-26 contest birds—Nos. F322 to F329 inclusive, Table 3—were the daughters of five hens that were entered in the 4th B.C. Egg Laying Contest at Agassiz in 1923-24. The ten birds entered in the 1923-24 contest laid 2422 eggs, the highest pen total that year, the records ranging from 205 to 286 eggs.

The eight birds mentioned before (F322 to F329) and one other (F321, Table 3) were sired by 810D (see Figures 1 and 3). These nine hens laid 2704 eggs, an average of 300.44 eggs each. Four of the nine daughters laid over 300 eggs. The remarkable performance of these nine daughters of 810D would seem to indicate that this male has transmitted high egg production to an exceptional degree. The size of the egg is the least satisfactory feature of the performance of his daughters since six out of his nine daughters laid eggs, after the first four weeks, that averaged in weight less than 2 ounces each. He has been mated again with D250 and other hens in order to secure a further test on his progeny.

FIGURE 3.

S.C.W. Leghorn male No. 810D, the sire of F 326 and eight other pullets in the pen that made a new official World's Record for ten birds by laying 2,986 eggs in 52 weeks. His nine daughters laid, on the average, 300.44 eggs each.

Table 3.

Summary of Information Concerning Ten Birds Entered by the University of British Columbia in the Sixth B. C. Egg Laying Contest at Agassiz, and Their Mothers.

CONTEST BIRDS 1925-26				MOTHERS			
Leg Band No.	Average Weight of Bird	Total Eggs Laid	Average Weight of Eggs	Leg Band No.	Average Weight of Bird	Total Eggs Laid	Average Weight of Eggs
	Lbs.	No.	Oz.		Lbs.	No.	Oz.
F321	4.3	294	1.87	D2339	3.7	287	1.91
F322	3.9	261	2.09	D246	3.9	286	2.00
F323	4.4	293	1.80	D246	3.9	286	2.00
F324	4.2	319	2.09	D247	3.6	240	2.00
F325	4.7	323	1.97	D246	3.9	286	2.00
F326	4.4	352	1.86	D250	3.5	271	1.98
F327	3.9	244	1.95	D244	3.9	229	2.20
F328	4.4	294	2.02	D248	3.5	243	2.09
F329	4.2	324	1.96	D246	3.9	286	2.00
F330	4.4	267	2.09	C2868	4.6	266	2.09

The tenth bird in the pen (F330) was sired by a son of B3020 (see Fig. 1) whose progeny has been used extensively in the breeding pens of the University at Point Grey.

With regard to size of egg, it is of interest to note that the weight of the eggs laid by some of the highest producers in the University pen was not typical of the weight of egg for other hens in the 1925-26 B.C. Egg Laying Contest. As an example, the registered hen with the highest record (335 eggs) laid eggs that averaged 2.17 ounces each. The leading pen (on points) laid 2556 eggs that weighed on the average $2\frac{1}{4}$ ounces each. Furthermore, 24 birds of the 36 that laid 300 eggs or over were registered. Since the weight of eggs laid during the first four weeks was not considered, unless they weighed less than one and two-thirds ounces when they were not counted in the totals, this means that the eggs laid by the 24 hens weighed, on the average, 2 ounces each, for 48 out of the 52 weeks.

As mentioned before, this short account of the performance and ancestry of ten S. C. W. Leghorn hens that made a World's Recor for number of eggs laid is written with th object of setting forth a few of the facts tha may prove interesting to poultry breeders an others interested in breeding. While no use ful purpose would be served by attemptin to explain or interpret the facts set forth nevertheless, it may not be out of place t conclude by pointing out that these record were made by birds of known ancestry. Fo that reason, it may be justifiable to assum that the performance of these ten hens wa not a matter of chance, but rather, was th result of systematic pedigree breeding.

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Saskatchewan

R. K. BAKER

Professor of Poultry Husbandry, University of Saskatchewan, Saskatoon.

When one looks for Saskatchewan on a map of the Dominion of Canada, one will have no difficulty in finding it at once because of its size and its central position; a practically unbroken stretch of agricultural land, 390 miles wide at the International Boundary, its surveyed area extending northward for approximately an equal distance. Over eight hundred thousand people live in this province, and there is room for three times as many more. Its people are prosperous. They show by their homes, schools and churches, by their automobiles and tractors, and by such conveniences as lighting plants, rural telephones and radios that it is a good country to live in.

Saskatchewan is usually thought of, even by the people who live within its borders, as that part of the Dominion which produces the larger share of Canada's exportable su plus of wheat, and possibly as contributin in almost the same proportion with cattle an hogs, and in a somewhat smaller way wi dairy products, but few realize that the val of the poultry and eggs shipped out each ye is exceeded by only four other crops, or th only one other province produces more pou try than Saskatchewan and that *no other pro ince* has so many hens per capita of populati or so great a surplus of eggs and poultry f sale. As this is preëminently a farming pro ince, there being seven people living on farn for one who lives in a city or large tow practically all poultry is raised on farm There are perhaps less than two dozen pou try farms keeping 500 hens or more, b since the Dominion Statistics for 1926 sho poultry totalling close to eight millions, the must be in the province more than one hun

red thousand farm flocks with an average of 70 birds each.

The long bright days of Spring and Summer, the abundance and cheapness of feeds, together with practically unlimited range, make the production of poultry and eggs easy and the cost low. These natural advantages make the Saskatchewan poultry raiser a hard man to compete with. True there are not many hens with authentic records of 300 eggs or more in the year, but the 240 to 260 egg hen is no longer a rarity and there are plenty of flocks with averages ranging from 150 to 175 eggs in the season. With bred-to-lay stock given reasonably good care, it is not unusual for flocks of pullets to show averages of 50 to 60 eggs by the end of February. During the winter months, prices obtained for new laid eggs in Saskatchewan cities are about on a par with those of Toronto or Montreal. This makes it possible for such a flock to have produced by March 1st, eggs of sufficient value to cover the cost of the pullets themselves, and to pay for their feed for the entire year.

Of course by referring to Dominion Government statistics the reader will notice that the average per hen production in Saskatchewan is only about the same as the average in any other province, and will conclude either that not all farmers have bred-to-lay stock or that some do not pay sufficient attention to housing and feeding. Both surmises would be correct. But low average production should not be ascribed to adverse conditions or to inability on the part of the owner to increase the size or efficiency of his flock of poultry. Let it rather be understood that the Saskatchewan farmer has learned to produce in large quantities only such crops as he can market to advantage.

Since this province was first formed the growth and progress of the poultry industry have been held back by the newness of the settlements, the lack of large cities to consume the produce and by great distances which, considered in connection with the smallness of the average farm flock, made it impracticable even to start any of the usual systems of collection for eggs and poultry. Lacking collection and marketing facilities and the incentive furnished when a choice article is paid for at a fancy price, it is not remarkable that for several years the number of poultry in the province has increased only in proportion to the increase in poulation.

For nearly twenty years the Saskatchewan Government assisted poultrymen in various districts with the marketing of their poultry by operating poultry fattening stations at creameries, and later by operating killing stations at Regina and Saskatoon, where live birds were received and graded, killed, cooled, graded again, packed and sold, the proceeds less operating costs being returned to the people who shipped in the birds. For two or three seasons the Department of Agriculture assisted in the cooperative marketing of dressed turkeys in car lots.

Since 1913 at the University of Saskatchewan, Poultry Husbandry has been taught as a required subject in both the Degree Course in Agriculture and in the Associate Course. From one to four Short Courses in poultry are given at the College each year. The correspondence of the Poultry Department has steadily increased until it seems probable that during 1927 more than 6000 letters will be received and answered.

By cooperation with the Department of Agricultural Extension several Short Courses in poultry are held each winter in different centres, and a Poultry Day is usually included in each Farmers' Short Course.

Since 1918 a flock culling service has been available to owners of standard bred poultry. Over 500 flocks are usually visited in a season and from 35,000 to 40,000 birds inspected. As a result of detailed information contained in the reports of inspectors, the University has been able to compile a list of names of poultrymen whose stock has been inspected each year and has steadily improved in quality, and who will have chicks or hatching eggs or stock for sale at reasonable prices. Naturally this list includes a large proportion of the finest flocks in the province, more than 120, each serving as a source from which dependable stock may be obtained, and each poultryman as he appreciates the service and wishes to have his name continued on that list, does his best to improve his own stock and to give each customer a square deal.

The R.O.P. Poultry Breeders Association of Saskatchewan is now in its second year. It has twelve members, and has hopes of doubling the membership by 1928.

Earlier in this article some marketing difficulties were mentioned. While these still

exist in some sections, in others they are being overcome. In 1925 an attempt was made to interest poultrymen in a cooperative marketing organization popularly known as "The Poultry Pool". A five year provisional contract was drawn up and by the Spring of 1926 a sufficient number had been signed to warrant the organization of The Saskatchewan Cooperative Poultry Producers Limited with headquarters at Regina, and with receiving stations at several railroad centres. Even before the organization meeting was concluded eggs began to arrive, consigned to the Poultry Pool. They kept coming in such rapidly increasing volume that the Saskatoon station was compelled to move to larger quarters three different times before the first of June. Almost a million dozen eggs were handled in less than four months. In July a culling campaign resulted in about thirty-two carloads of old hens being shipped out of the country. In November the pool shipments of dressed turkeys began, twenty-five carloads in all being shipped and sold to advantage. Meantime the number of pool contract signers has increased to eighteen thousand, they have held their first annual meeting and have begun on their second year's business. Payment on a quality basis has given pool members an incentive to take care of their poultry, to gather eggs frequently and market them twice each week. Saskatchewan eggs are graded much better than they were in former years, and prices paid to producers last summer averaged higher in consequence. Profiting by last year's experience there should be a further improvement in the quality of eggs and poultry, and increase in quantity and a lower handling cost. If these materialize the future of Saskatchewan's poultry industry should be sufficiently bright to satisfy even the most exacting critic.

Alberta

J. H. HARE

Poultry Commissioner, Dept. of Agriculture, Edmonton

Alberta poultrymen sell annually about eight million dollars worth of poultry products. Most of this income is from the sale of eggs which for the most part are consumed in our own home markets. In 1920 the province was actually short of her own needs as regards eggs, but the industry since that time has been growing rapidly and there is now an annual surplus of upwards of one hundred car loads.

The turkey crop is an outstanding feature of our industry. A favorable climate and specialization in some parts of the province have resulted in a volume of production which meets our own consumptive requirements and leaves fifty car loads or more each year for the larger consuming centers elsewhere. Ducks are not grown to any extent here and geese have been bringing such small returns that their production is largely discouraged.

For a young province the poultry industry is making what would appear to be satisfactory progress. Ten years ago the poultry population was 3,263,000. Today it is 6,659,000 which is an increase of over one hundred percent. Diversified farming is strongly emphasized and poultry keeping in a small way is a feature of nearly every farm. Work in marketing has been carried on aggressively in this province. In 1917 the Provincial and Dominion Departments of Agriculture agreed on a joint project to improve quality, eliminate waste in marketing and apply the principle of paying for eggs and poultry according to grade. Since that time many groups of farmers have organized for cooperative shipping and during the greater portion of the period a central grading and selling agency has been operating. This movement has resulted finally in the organization of an egg and poultry pool which is now operating and has a membership of over 4000 farmers. A number of definite benefits have accrued to the farmers as a result of this cooperative effort. Better prices have been obtained, especially by farmers in outlying districts who have suffered from the

lack of marketing facilities. The producers of good quality eggs have been paid a distinctly better price, in consequence of which the general quality has improved. The organization of local associations has stimulated interest in poultry work and this has resulted in bigger and better flocks.

Quite a distinct improvement was effected by the organization of the marketing of live fowl. Formerly the poultry of the country was shipped by express to the larger centres. The Marketing Service and Pool introduced live poultry cars and had the live fowl come forward by freight which greatly reduced the cost of transportation and incidentally resulted in the opening up of new markets in other provinces for the heavy stock in which we specialize.

Good results were obtained by the organization in the pool shipping of dressed turkeys. Formerly the turkeys of many districts were shipped live to the larger centers for slaughter and in the course of transit by express the finish of the birds was lost. The new arrangement involved the organization of local killing centers by Dominion and Provincial Government officials cooperating. The work of local killing was carefully supervised and the birds were killed when in prime condition. This resulted in a better pack and a better price.

Alberta has an accredited flock scheme which is sponsored by the Dominion Poultry Division. The first association was formed at Vegreville with thirteen charter members. One unique feature of this scheme is the condition of membership. To qualify the producer must procure up-to-date brooding equipment and buy 250 day-old-chicks of a stipulated breed. The work of supervision in this work is the joint responsibility of the Dominion Department and the Provincial District Representative. Recently one such association launched a hatchery enterprise to supply the needs of members first and sell to outsiders as far as space would be available.

The Provincial Poultry Branch has inaugurated a Record Flock scheme which has an enrolment of 120 flocks in various parts of the province. The breeding, feeding and management is directed by provincial officers who make periodical visits to the homes of entrants and in return for the service, members agree to keep careful production records. In connection with this scheme the Provincial Branch is publishing a Service Bulletin which contains seasonal advice and general directions and information and a report of the production by months of the leading flocks in the group.

Both Provincial and Dominion Departments have conducted culling demonstrations and their officers have culled a great many flocks. This work is usually confined to districts where ten or more farmers apply for the service.

Large flocks and specialized poultry farms are not numerous in Alberta and trapping is not a general practice, but the province boasts an R.O.P. Association with an active membership of about twenty breeders.

The Provincial Poultry Branch operates a Breeding Station at Edmonton and a hatchery in conjunction which provides a source of better breeding stock for farmers.

TRANSPORTATION

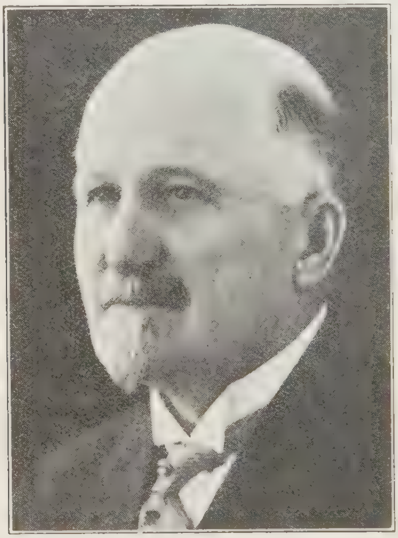
When purchasing your transportation to Ottawa for the Congress, buy a single fare ticket. You can return on the certificate plan at half rate.

Who's Who At The Congress

It is impossible, in the limited space available, to publish photographs and biographies of all the important visitors to the Third World's Poultry Congress. We have therefore selected only a comparatively small number, but these will be sufficient to demonstrate the importance of the event and to illustrate the high standing of those who are contributing to its success.—EDITOR.

HON. W. R. MOTHERWELL

Born at Perth, Ontario, January 6, 1860. Received his Associate Diploma from the Ontario Agricultural College in 1882, and since that date has owned and operated a 640 acre farm at Abernethy, Saskatchewan.



On the formation of the Saskatchewan Government in 1905, Mr. Motherwell was appointed Provincial Secretary and Commissioner of Agriculture and was Minister of Agriculture for that Province until 1918. He became Minister of Agriculture for Canada in 1921 and occupies that position at the present time. He is Honorary Chairman of the Third World's Poultry Congress Committee.

J. H. GRISDALE

Born at Ste. Marthe, Quebec, 1870. Completed his agricultural course at the Ontario Agricultural College and the Iowa State College, receiving the degree of B.Agr. from the latter institution in 1898. Received the Honorary degree of B.Sc.A. from Laval University in 1918.

Dr. Grisdale was Agriculturist at the Central Experimental Farm, Ottawa from 1899 until 1911, and Director of Dominion Experimental Farms from 1911 until 1919, when he was appointed to his present position of Deputy Minister of Agriculture for Canada. His specialty is Animal Husbandry and he has made a close personal

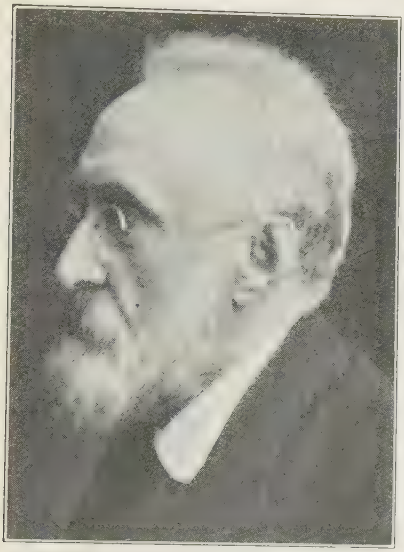
study of European markets. He is a member of the American Genetic Association and a Fellow of the American Association for the Advancement of Science. He is Chairman of the Third World's Poultry Congress Committee.

EDWARD BROWN

Born in 1851. Commenced to breed standard-bred poultry as early as 1873 and won the first cup offered for Leghorns in Britain, at the Crystal Palace in 1875. In 1897 he commenced a study of poultry conditions and methods in European countries, and these have since extended as far east as Russia and the Balkan States as well as all parts of North America. He made an enquiry into the poultry industry of Ireland in 1887, and inaugurated instruction in Poultry Husbandry in Great Britain and Ireland in 1892.

In 1895 Mr. Brown became Lecturer in Poultry Husbandry at Reading College and in 1898 established the College Poultry Farm, Theale, for practical training and experimental work. He was Honorary Secretary of the National Poultry Organization from 1899 until 1913.

Mr. Brown was elected the first President of the International Association of Poultry Instructors and Investigators in 1912, a position which he still occupies. He was President of the First World's Poultry Congress at The Hague, Holland in 1921, of the Second



Congress at Barcelona, Spain in 1924, and is President f the Third Congress, at Ottawa, Canada in 1927.

Since 1911 Mr. Brown has devoted his efforts largely o the establishment of the National Poultry Institute England), which is now operating under a grant of 50,000 from the British Government, supplemented by grant of £6,500 from those engaged in poultry husandry. In addition to the Central Institute at Newort, Salop, for higher teaching and practical experiments, the Institute also directs (1) a Breeding Research tation at Cambridge, (2) a Nutrition Research Station Cambridge, (3) a Disease Research Station at Addleone, (4) an Egg Breeding Station at Reaseheath and 5) a Table Poultry Breeding Station at Wye.

Mr. Brown is the author of many books, articles and ports. He was elected a Fellow of the Linnaean ociety of London (F.L.S.) in 1880 and has been a ember of the Royal Agricultural Society of England nce 1885.

E. C. Elford

F. C. ELFORD

Born in Ontario, June 29, 1871. He was in charge of a poultry breeding station at Holmesville, Ont., from 1901 until 1904 and Chief of the Poultry Division in the Dominion Live Stock Branch from 1904 until 1906. He was then appointed to the staff of Macdonald College as Manager and Lecturer in the Poultry Department, a position which he occupied until 1912. After a short time spent in commercial work he received the appointment of Dominion Poultry Husbandman in 1913 which he still holds.

Mr. Elford was one of Canada's two delegates at the Second World's Poultry Congress at Barcelona, in 1924, and is Chairman of the Executive Committee and General Director of the Third Congress to be held at Ottawa, Canada, in July, 1927. He was President of the American Association of Instructors and Investigators in Poultry Husbandry in 1924.

W. A. BROWN

Born at Meaford, Ont., April 30, 1885. Graduated from the Ontario Agricultural College in 1908 (B.S.A.) and from the University of Maine in 1910 (M.S.).

Mr. Brown was Professor of Poultry Husbandry at the University of Maine from 1908 until 1911, Poultry Specialist in the Dominion Live Stock Branch from

1911 until 1917, and has filled his present position of Chief of the Poultry Division in the Live Stock Branch since 1917. He is Vice-Chairman of the Congress Executive and Chairman of the Canadian Exhibits Committee.

The standardization of eggs and dressed poultry, and the R.O.P. for poultry, are due to Mr. Brown's efforts and are now under his direction.

ERNEST RHOADES

Born at Lincoln, England, August 16, 1885. Graduated from Macdonald College in 1912 (B.S.A.) and was Assistant Agricultural Editor of the *Family Herald & Weekly Star*, Montreal, until 1916. In August, 1916 he became Assistant Chief of the Poultry Division in the Dominion Live Stock Branch, a position which

he still holds. He was selected as Secretary of the Third World's Poultry Congress and since early in 1926 has been permitted to give all his time to that work.

Mr. Rhoades accompanied Mr. F. C. Elford as a delegate to the Second World's Poultry Congress at Barcelona, Spain, in 1924. He is Secretary of the Canadian National Poultry Record Association and other associations.

HON. JOHN S. MARTIN

Born in Ontario. Graduated from University of Toronto (B.A.). Elected to Ontario Legislature in 1923 and became Provincial Minister of Agriculture in July of that year.

Mr. Martin has specialized in breeding pure bred White Wyandottes for the past twenty years and is

known as the "Wyandotte King". He owns and operates, at Port Dover, Ont., one of the largest poultry farms in Canada and his poultry has gained a world wide reputation. In 1926 he won a silver cup for the best display for the twentieth consecutive year at the New York State Fair and also won a silver cup for the best display at the Sesquicentennial Show in Philadelphia.

M A. JULL

Born at Burford, Ont., August 26, 1885. Graduated from the Ontario Agricultural College in 1908 (B.S.A.), McGill University in 1919 (M.Sc.) and the University of Wisconsin in 1922 (Ph.D.). He was connected with the West Virginia Experiment Station 1908-09, British Columbia Department of Agriculture 1909-11,

Head of the Poultry Department at Macdonald College 1912-23. He has been Poultryman in the United States Bureau of Animal Industry since 1923.

Dr. Jull is the author of numerous scientific articles and bulletins, and has recently completed a very comprehensive work on "The Races of Domestic Fowl" which was published in the April, 1926, issue of the *National Geographic Magazine.*

PERCY A. FRANCIS

Born in Wiltshire, England. Poultry Instructor t Antrim County Council from 1901 until 1909. Poultry and Dairying Inspector under the Dept. of Agriculture and Technical Instruction in Ireland, 1909-1- Agricultural Instructor, Board of Agriculture fo Scotland, 1914-20. In 1920 Mr. Francis was appointed Poultry Commissioner in the British Ministry of Agriculture and Fisheries, and has occupied the position since that time.

Mr. Francis is a member of the Council of the International Association of Poultry Instructors and Investigators. During the war he represented the Boar

of Agriculture for Scotland on numerous Departmental Committees in London, for which service he was awarded the M.B.E. (Member of the British Empire).

F. A. E. CREW

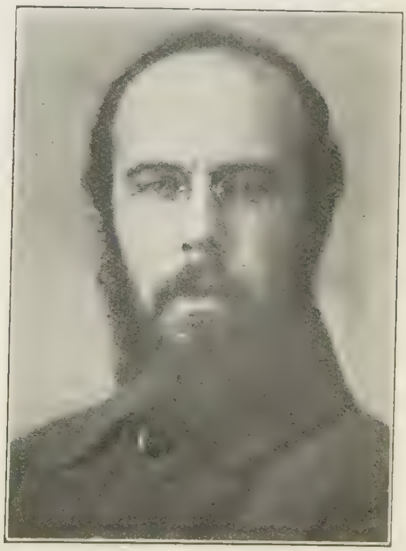
Holds the degrees of M.D., D.Sc., Ph.D. and is a Fellow of the Royal Society of England. Occupies the joint position of Director of the Animal Breeding Research Department and Lecturer in Genetics at the University of Edinburgh.

Dr. Crew is the author of "Animal Genetics" (Oliver d Boyd, Edinburgh), "The Genetics of Sexuality in nimals" (Cambridge University Press) and some 100 entific papers, including certain papers on sex-reversal the fowl, on the effect of thyroid medication, and of sectomy in the fowl and on the length of life of the wl's sperm.

C. S. TH. VAN GINK

Born in 1890 near Amsterdam, Holland. Has been interested in standard-bred poultry since boyhood. Visited the United States in 1911 and remained there until 1913 on the staff of the *American Poultry Journal.* Returned to Holland and was illustrator of the Dutch Utility Poultry Standard as well as Director of the poultry experiment stations at Amersfoort and Landsmeer. Was Secretary of the First World's Poultry Congress, held at The Hague in 1921. Since 1920 he has been Chief Editor of *Avicultura*, one of the oldest and largest poultry journals in Europe.

In recognition of his services to the poultry industry, Mr. van Gink received the Royal Orders of Holland, Denmark and Sweden and the Mérite Agricole of France and Spain.



ALEXANDER S. SEREBROVSKY

Born in 1892. Educated at Moscow University

1905-14. Since 1919 he has been Chief of the Department of Genetics at the Anikuvo Genetical Station, Moscow. He is also Lecturer in Genetics and Professor of Poultry Breeding at the Zootechnical Institute of Moscow.

ALWIN W. PAPPENHEIMER

Born in New York city, 1878. Graduate of Harvard University in 1898 (A.B.) and of Columbia University in 1902 (M.D.). Interne, Bellevue Hospital, 1903-05 and Pathologist at the same institution 1905-12. Has been associated with the Dept. of Pathology at Columbia University since 1912 and is at present Professor of Pathology.

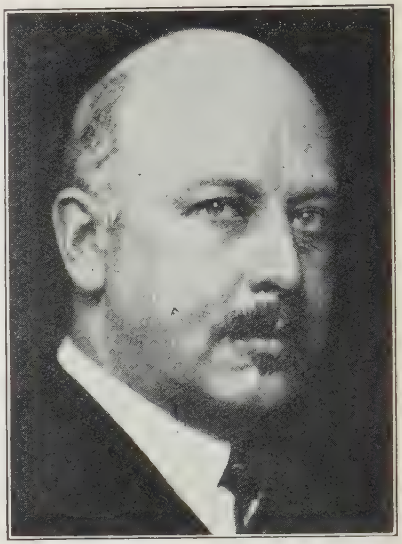
Dr. Pappenheimer's fields of work include pneumonia, relapsing fever, histology and physiology of thymus gland, experimental rickets, rheumatic fever, leg weakness in chickens, fowl paralysis, etc.

Dr. Pappenheimer is a Fellow of the New York Academy of Science and the New York Academy of Medicine, and a member of the following Societies:—Am. Assoc. of Path. and Bact., Am. Soc. for Exp. Path., Am. Assoc. for Adv. Sc., Soc. Exp. Biol. and Med., N.Y. Path. Soc., Harvey Soc.

JOHN ROBBINS MOHLER

Born at Philadelphia, Pa., May 9, 1875. Graduated from the University of Philadelphia in 1896 (V.M.D.). Was in the Medical Department at Marquette University from 1897 until 1899, and during this period was also doing inspection work under the U.S. Bureau off Animal Industry. He became Assistant Pathologist in 1900, Zoologist in 1901, Chief of the Pathological Division in 1902, Assistant Chief of the Bureau in 1914 and Chief of the Bureau in 1917. He received an Honorary D.Sc. from Iowa State College in 1920.

Dr. Mohler is a member of the following scientific societies:—Am. Vet. Med. Assoc., Soc. Am. Bac., Soc. Exp. Biol. & Med., Am. Public Health Assoc.,



Wash. Acad. Sci. Honorary member of Alpha Psi, Phi Kappa Phi. Translated Edelmann's Meat Hygiene (1908), also (Editor) Hutyra and Marek's Special Pathology and Therapeutics (1912), Ernst's Milk Hygiene (1914). He is the author of numerous articles on pathology, bacteriology and meat inspection.

LEO. F. RETTGER

Graduated from the University of Indiana in 1896 (B.A.) and 1897 (M.A.). Received his Ph.D. from Yale University in 1902. Was a student at the University of Strassbourg in 1903 and a Research Fellow

at the Rockefeller Institute for Medical Research from 1904 until 1906.

Dr. Rettger has been Professor of Bacteriology at Yale University since 1919 and Bacteriologist (Animal Diseases) at the Storrs Experiment Station since 190[illegible]

E. T. HALNAN

Born December 29, 1888. Educated at St. Olave's Grammar School, London and Trinity College, Cambridge (M.A.).

Mr. Halnan was attached to the staff of the Animal Nutrition Institute, Cambridge, at its initiation, as a Research Assistant, and remained until 1920 when he was attached to the British Ministry of Agriculture as a Senior Inspector. He resigned from this position in 1922 and returned to the Animal Nutrition Institute to take charge of the newly created Poultry Nutrition Section, which position he still occupies.

Mr. Halnan is the author of numerous scientific papers, particularly on poultry nutrition.

MAURICE TRYBULSKI

Graduated from the Forestry Institute of Petersburg, Russia and the Agricultural Academy of Pulawy, Poland. He then specialized in the breeding of poultry and small domestic animals. Travelled extensively, visiting the most important breeding farms in Russia, Latvia, Estonia, Finland, Sweden, Germany, Austria, Csecho-Slovakia and France. Owned and managed a large poultry and rabbit breeding farm in Russia.

Mr. Trybulski went to Poland in 1920 and assisted in the organization of the "Central Committee of Poultry Breeding". This organization was incorporated in 1921 with Mr. Trybulski as its Chief.

Mr. Trybulski organized the first all-Polish Poultry Exhibition in Warsaw in 1922. He is Chief of the Poultry Breeding Division in the Polish Ministry of Agriculture and Lecturer in Poultry Breeding at the High Agricultural College in Warsaw. In 1925 he became Manager of the Experimental Farm at Julin. He is a member of many breeders' associations and technical societies. Editor of *Polish Poultry* and author of several books and scientific papers.

HON. HARRY R. LEWIS

Born at Providence, Rhode Island, October 14, 1885. Graduated from Rhode Island State College in 1907 (B.S.) and 1916 (M. Agr.).

Professor of Poultry Husbandry, Baron de Hirsch Agricultural School, 1907-09, and Professor of Agriculture 1909-10; Instructor in Dairying and Poultry Husbandry, Rutger's College, 1911-14, Associate Professor 1914-15, Professor of Poultry Husbandry, New Jersey State University, 1915-21.

Mr. Lewis is now President and Managing Director of the U.S. National Poultry Council, with headquarters at Davisville, R.I. He is a Director of the International Baby Chick Association, of which he was Managing Director for four years.

He is the author of Poultry Laboratory Guide (1910), Productive Poultry Husbandry (1913), Poultry Keeping (1915), Poultry Laboratory Manual (1918), Making Money from Hens (1919) and numerous papers and bulletins. He is a member of Kappa Sigma & Phi Kappa Phi.

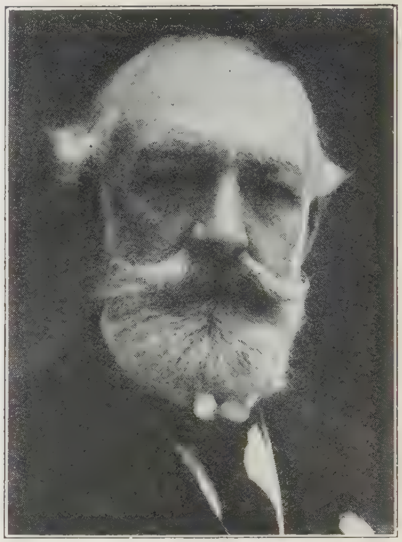
GUSTAVE F. HEUSER

Graduated from Cornell University (B.S., M.S., Ph.D.). Dr. Heuser is Professor of Poultry Husbandry at Cornell University. He is also Secretary-Treasurer of the International Association of Poultry Instructors and Investigators.

His specialty is poultry nutrition.

W. A. KOCK

Adviser for the Royal Danish Agricultural Society from 1913 until 1920, when he was appointed State Counsellor in Poultry Culture. He is Vice-president of the International Association of Poultry Instructors and Investigators. He was official delegate from Denmark to the First and Second World's Poultry Congresses, and is the author of several books, reports and technical papers.



DON SALVADOR CASTELLO

Born in 1862. Educated at the University of Bar celona and at the agricultural schools of Madrid i Spain and Gembloux, Belgium. He founded an opened the Royal Spanish Poultry School at Areny de Mar, near Barcelona, in 1896 and is still Directo of this institution. In 1904, 1910, 1914 and 1915 Pro fessor Castello gave courses in poultry husbandry in Mexico, the Argentine Republic, Uruguay and Chile In 1902 he organized an International Poultry Exposi tion at Madrid.

Professor Castello was the representative for Spai at the First and Second World's Poultry Congresses held at The Hague and Barcelona respectively. He i the President of the International Association of Poul try Instructors and Investigators and the author o many educational books.

ALFRED SCHACHZABEL

Dr. Schachzabel is at the Museum of Ethnology at Berlin, Germany. He will give a paper at the Third World's Poultry Congresses on "A General Review of the Most Important Treatises that have appeared in Germany in 1926 and 1927 on the Combatting of Infectious Diseases".

B. J. C. te HENNEPE

Born in 1884. Studied at the Veterinary High School in Utrecht. He founded a private experiment station for ducks and fowls at Volandam, Holland, in 1923, for feeding and breeding experiments. He is Editor of the Poultry Section of the International Review of Agriculture, published by the International Institute at Rome. His present position is Bacteriologist at the State Serum Institute at Rotterdam, Holland. He was a delegate at the First and Second World's Poultry Congresses.

INFORMATION FOR CONGRESS VISITORS

Full Congress membership is $5.00 and includes admission to sessions and exhibition (with car), all Congress functions, in addition to a copy of the "Congress Proceedings"—a 500 page volume with 50 pages of illustrations.

Associate membership is $3.00 and includes all the privileges of full membership except the "Congress Proceedings".

Applications for membership should be sent at once to the Secretary, World's Poultry Congress, Ottawa.

Those who are taking out memberships should state what accommodation they require. If other adult members of the family accompany those holding Congress membership and wish to attend Congress functions, sessions, etc., they should take out associate memberships. Accommodation rates—double room $3.00 per day; single room, $2.00 per day.

Poultry Research and Investigation at Macdonald College.

W. A. MAW, R. L. CONKLIN, L. G. HEIMPEL

The urgent need for fundamental research and investigation of value in solving the difficulties encountered by the practical poultryman in actual production work has been the means of creating closer co-operation by the various departments of allied sciences at the Agricultural Colleges and Experimental Stations. To obtain the greatest value from any piece of experimental work it is generally advisable first to have it outlined and discussed by a Committee of allied workers in order that all possible phases of the work may be taken into consideration and incorporated where feasible, and then secondly, to have the results obtained analyzed by the most competent authorities. Macdonald College has adopted a system whereby committees of interested workers are appointed in the various lines of investigation to arrange for the planning and execution of major projects. For instance, an Animal committee will handle all major projects coming under the general heading of live stock investigation whether they be production or purely scientific investigation. Poultry investigation will come under the supervision of the Animal committee.

At the present time three main projects are being worked on in Poultry Husbandry with the co-operation of the departments of Veterinary Science, Zoology and Agricultural Engineering. These projects are firstly, "One Phase of Poultry Breeding" (an outline follows); secondly "Intestinal Parasitism"; and thirdly, "Poultry House Design and Ventilation" (an outline follows). Naturally other projects of minor nature are also being carried on at present.

Poultry House Design and Ventilation Project.

L. G. HEIMPEL

Dept. of Agricultural Engineering

Authorities on poultry raising in Canada at the present time are agreed that the most satisfactory poultry house is that in which no particular effort is made, in cold weather, to maintain a temperature difference between the inside and the outside of the house. The advantages of this method of housing are obvious. It makes for economy of construction because nothing very much more elaborate than a draft-proof structure is demanded. Since only a small temperature difference is to be maintained almost unlimited entrance of outside air is permissible if done in a way that will not cause serious drafts. This overcomes the vexatious ventilation problem.

There is no doubt that with dry floors, a rain-proof roof, draft-proof walls on three sides of the pen and with sufficient window area to admit plenty of light and air, this type of house will give better results than any other type so far tried out. Yet, just as soon as the cold becomes extreme, egg laying drops off. This is the experience of every poultry keeper in a climate where the temperature may go down to the neighbourhood of zero Fahrenheit for anywhere from a few days to a few weeks at a time. Though the "cold house" gives better results than previously tried out "warm houses" the results secured are far from what is desirable for the winter housing of the laying flock.

This conclusion led to the planning of a co-operative experiment between the Poultry and Agricultural Engineering Departments of Macdonald College. The object of this work is the production of a poultry house in which the destructive extremes of low temperature in the cold spells of winter can be prevented and this without the use of excessively expensive construction or of artificial heat

Two pens each 20 x 24 feet of a long laying house are employed in the preliminary experiment. One is tightly sheeted on the inside on both walls and ceiling; the air spaces between the studs are filled with 4 inches of "Insulex" and the space between the rafters stuffed tightly with straw. Windows are doubled while air supply and ventilation are supplied by a commercial ventilation system.

The second pen is of the "cold" type, having a straw loft and depending for fresh air supply upon cotton covered windows, open windows, as well as on specially designed intakes on one side of the house. An ordinary cupola above the straw loft is provided as a ventilation outlet.

Recording thermometers were installed in both pens and these were checked by maximum and minimum thermometers, while periodic examination of air samples for CO_2 and moisture were made. Although the averages for all the months have not yet been calculated, the following are the results for the month of December last. The average minimum temperature outside for this period was 6.5° Fahr. The average minimum temperature difference between the inside of the "warm" pen and the outside was 26.1° Fahr. The average minimum temperature difference between the "cold" pen and the outside for the same period was 14.8°. The average minimum temperature in the "warm" pen was 11.3 degrees warmer than that of the cold pen. The effect of more comfortable living conditions was noticeable in the birds of this pen throughout the entire winter.

It is the intention to continue this work for several seasons and, if circumstances should demand it, to increase the scope of this work. Egg production comparisons could not be made this season because the birds in the two pens were of sufficiently different ages to make such comparison of no value.

Poultry Breeding Project.

R. L. CONKLIN

Veterinarian

The live stock industry of to-day is suffering a great deal from losses which may be attributed to breeding disturbances. We noted the increase of Tuberculosis with the distribution of pure bred stock, now we have another problem to contend with; and one which may be even more costly than Tuberculosis. It is well to speak of these losses as breeding disturbances in order to allow the mind to remain in a tranquil state. Eventually, however, we must call the condition breeding diseases, since they are deviations from the normal.

Breeders of cattle all attribute their losses to poor luck, breeding at the wrong sign of the moon, accident or to *A. abortus.* The poultry people blame the incubator, the weather or *Sallmonella Pullora* for their unfortunate results during the breeding season. In both classes of live stock they have not been so willing to make a concerted effort to locate the true causes of disease. Each class of live stock mentioned may be tested by an agglutination test ("blood test") to determine the individuals infected with organisms which have been mentioned. Curiously enough the breeder and laboratory worker have been inclined to place the utmost faith in the animals that fail to give a reaction to these tests. A negative cow is not expected to abort. The negative fowl is supposed to produce fertile eggs that hatch and result in giving large, healthy offspring. The search for *A. abortus* and *S. pullora* has not given the owners the relief and satisfaction which they anticipated. Cows continue to abort or exhibit signs of genital disease and hens lay infertile eggs or eggs that fail to hatch.

In view of our present day knowledge of the breeding disease problem, one must seek still further to find a solution. The male has recently and only recently been considered as a factor in genital disease of the bovine and equine. Many workers have observed the seminal fluid of the fowl but have not made a detailed study of it. There is every reason to believe that the examination of the rooster may be of equal importance to that of other species.

In a series of experiments which the Veterinary and Poultry Departments are carrying out, we are attempting to study the seminal fluid of the avian species. We are searching for information regarding the results of small and large matings by males of different ages and the condition of the spermatozoon after the male bird has mated the females over varying periods of time. We wish to arrive at a point where more definite data may be available with regard to the number of services per day which may be obtained and still have the power of fertility retained. All breeders tell one not to overuse the male—but "when is a male overused?"

Cattle breeders often observe cows returning to oestrum at the end of six to nine weeks. In the period during which oestrum does not appear they are supposed to be pregnant. The poultry breeder has a similar problem but one that has been taken in a very matter of fact way. He candles the incubated eggs at three to five days; eggs are removed as not fertile and as blood rings. The infertiles may be likened to the cows that fail to conceive whilst the blood rings are in the same category as the early aborts of bovine species.

The remaining dates at which eggs are examined and the dead germs removed from the incubators correspond very closely with the periods of death of the embryos in utero.

Gestation of calf—280 days.	Chick–21 days
40 days	3 days
190 "	14 "
200 "	15 "
227 "	17 "
240 "	18 "
253 "	19 "
267 "	20 "

Roughly it will be noted that one day of gestation for the chick is equivalent to 13.3 days of the bovine.

No attempt is being made at this time to explain in detail the technical results obtained by this study. The studies of the spermatozooa have been carried out on much the same lines as with bovine samples. Pathological changes of these cells are very much like those obtained in other species.

The objects in view are the following:

1. To study the condition of the sperm of various male birds—before service, at periods during their use, after known number of copulations on specific days, and at definite periods when incubation results indicate apparent changes in the viability of the sperm by weak or dead embryos during the early stages of development.

2. To determine the relation of the number of services to embryo mortality and viability of sperms as may be indicated by micro-examination together with hatching of eggs.

3. To note selectivity of females by males.

4. To ascertain the period of time necessary to fertilize all females in given pens of varying sizes with the light and general purpose types of fowl. (S.C. White Leghorn and Barred Plymouth Rock are used in this project.)

5. To determine the period of death of embryos in eggs under incubation.

6. To carry out a bacteriological study of representative eggs and dead embryos.

7. To attempt to correlate the seminal examination with data obtained regarding fertilization, number of threads, percentage death at various periods of gestation, hatchability of eggs and their viability of chicks.

La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

L'Aviculture dans la Province de Québec

J. D. BARBEAU

C'est en 1914 que le Service de l'Aviculture provincial fut définitivement organisé. Il avait eu comme précurseur l'Union Expérimentale des Agriculteurs de Québec, qui avait elle-même organisé et dirigé vingt-deux stations d'élevage. Mais l'Union s'était surtout appliquée à procurer au poulailler, comme dans les étables, écuries, etc., plus d'air pur et de soleil, plus de ventilation surtout. C'est à l'Union Expérimenatle, grâce aux primes qu'elle offrait, que l'aviculture est redevable des premiers poulaillers "autonomes", dits poulaillers froids, dans la Province.

En 1914, notre Service débuta par seize stations d'élevage, un commencement d'organisation avicole dans trente-neuf écoles ménagères et une première distribution d'oeufs (1,000 couvées) aux écoliers de la Province.

De concert avec la Coopérative des Fromagers de Québec, aujourd'hui la Coopérative Fédérée de Québec, le Service de l'Aviculture s'efforça de promouvoir le commerce coopératif des produits avicoles, de là, la publication de nouvelles circulaires, mais surtout par le travail d'enseignement pratique fait sur place par les instructeurs avicoles.

En 1915, nous comptions déjà ternte- trois stations d'élevage devant être subventionnées deux années consécutives, si elles donnaient satisfaction, puis tenues en opération, mais sans subvention, une troisième année. Nous avons cru—et les événements nous one donné raison — qu'après deux années d'opération subventionnées, il valait mieux porter ailleurs la subvention, afin de répandre le plus possible l'enseignement pratique et démonstratif des stations.

La même année, les cercles de fermières commençaient à bénéficier de la distribution d'oeufs. Dans Chicoutimi, en un mois, douze fermières se font construire des poulaillers modernes.

Le nombre et la capacité des incubateurs coopératifs sont augmentés, et 10,082 poussins en éclosent.

Des sociétés coopératives se forment pour la vente en coopération des oeufs et autres produits avicoles. La Société des Fromagers, aujourd'hui la Coopérative Fédérée de Québec, vend en quelques mois 31,217 lbs. de volailles et 2,246 caisses d'oeufs classifiés, soit 667,380 douzaines. C'est un commencement.

Des industriels, à St-Hyacinthe et à Québec, ouvrent des fabriques et des magasins d'incubateurs et de divers accessoires de l'outillage avicole.

Pendant la guerre la rareté et le coût excessif des grains rendit plus difficile le travail du Service de l'Aviculture. Il fallait combattre le découragement qui menaçait de gagner les éleveurs. Nous avons alors supplée à la rareté des grains en induisant la population à tirer parti des vieux chevaux dont on se débarrasse généralement à l'automne. A cet effet, le Service procura aux deux tiers du prix du gros des broyeurs d'os à pouvoir, capables de réduite en farine les os et les viandes de rebut de toute une région.

Les lignes qui précèdent donnent un aperçu général des travaux de notre Service durant ses premières années d'existence. Ces travaux ont été poursuivis sans relâche depuis, et divers autres moyens d'enseignement et de propagande ont été aussi employés.

Je me contenterai maintenant d'ajouter certains tableaux, qui résument succinctement les oeuvres principales du Service de l'Aviculture.

Travail des instructeurs depuis 1917 jusqu'au 30 juin 1926:—

Préalablement à 1917, nous ne compilions pas annuellement—et pour cause—les travaux des instructeurs. Mais voici comment s'analysent, depuis 1917, ces mêmes travaux.

Démonstrations pratiques—

Leçons d'abatage et emballage de la volaille pour le marché	1,602
Démonstrations de chaponnage	505
Leçons d'incubation	1,740
Leçons de sélection	3,605
Leçons de mirage et d'emballage des oeufs	632

Basses-cours visitées—

Pour incubation et élevage	4,034
Pour sélection de troupeaux	6,322
Pour démonstration ou serveillance d'engraissement de volailles	564
Pour cas de maladie	1,493
Pour inspection et aménagement de basses-cours	9,953
Pour construction de poulaillers	1,203

Autres travaux—

Visites de sociétés coopératives, sociétés avicoles, etc.	626
Conférences	1,638
Démonstrations et conférences aux expositions	446
Visites spéciales de stations avicoles officielles	445
Participation aux conventions et assemblées diverses	1,098
Nombre de jours de travail pour ces divers chefs	16,881
Nombre d'instructeurs employés depuis 1914	36

Stations Avicoles

167 stations avicoles, dont 53 fonctionnent à l'heure actuelle, ont été organisées depuis la fondation du Service.

De plus, 23 postes d'incubation coopérative ont été établis. Onze sont encore en opération sous le surveillance directe du Service et leur capacité d'incubation varie de 3,000 à 16,000 oeufs.

Expositions Avicoles

19 associations avicoles ont tenu 112 expositions spéciales de volailles jusqu'au 30 juin 1926.

Nombre approximatif d'exposants	4,400
Nombre approximatif d'oiseaux et d'exhibits	59,000

Le Ministère de l'Agriculture a contribué à ces expositions sous forme d'octrois directs, pour la somme de $37,726.56, soit plus de $300.00 par expositions.

De plus, 2 expositions spéciales de dindons ont été organisées dans le comté de Charlevoix.

Distribution d'oeufs

23,825 enfants des écoles rurales ont reçu 286 940 oeufs d'incubation, et les cercles de fermières out bénéficié de 103,512 oeufs, soit un total de 390,452 oeufs.

Cours populaires d'aviculture

Depuis 1921, ces cours, dont la durée est d'au moins quatre jours, ont été tenus, une fois l'an, à Ottawa, au Collège Macdonald, (St-Anne-de-Bellevue) (deux années), à Ste-Anne-de-la-Pocatière, à Princeville et à Oka.

Concours Avicoles dans les Fermes

Des concours de basses-cours, ont été organisés en 1919 dans les districts suivants: Deux-Montagnes, Arthabaska-Mégantic, Yamaska, St-Hyacinthe.

157 personnes y ont pris part comme concurrents.

Petites Expositions

A titre d'essai nous avons aussi organisé, de concert avec les agronomes de district, de petites expositions avicoles ou "journées avicoles" dans des centres où les oiseaux de race pure sont encore que peu connus.

Sélection des Volailles

Depuis 1922, une attention spéciale a été apportée à la sélection des pondeuses dans les basses-cours de fermes. De 1922 au ler mars 1927, dans 5,157 troupeaux sélectionnés, comprenant 403,895 volailles, 105,319 sujets ont été éliminés.

Constructions de Poulaillers de Démonstration

Avec la collaboration de l'Union Expérimentale nous avons fait ériger 325 poulaillers modèles de démonstration dans certaines paroisses où ces constructions étaient encore inconnues. Une légère prime était acordée par l'Union Expérimentale.

Régénération des Races de Dindons

434 éleveurs de dindons, répartis dans huit comtés, ont bénéfiicié de la distribution de 553 dindons reproducteurs faite en vue de l'amélioration des races.

Une foire aux dindons, premier essai du genre dans la Province, a été organisée à la

Baie-St-Paul, (Charlevoix), en décembre 1923, 150,000 lbs. de dindons et volailles abattus y ont été vendus à des prix satisfaisants pour les producteurs. En décem-bre 1924, 1925 et 1926, d'autres foires ont été encore organisées avec succès à la Baie-St-Paul. En 1924 tout spécialement, en plus les dindons, oies, canards et poules et pou-ets abattus qui ont été vendus directement ur place aux maisons de commerce de Mont-éal, les membres de l'Association des pro-ucteurs de dindons du comté de Charlevoix onsignaient à la Coopérative Fédérée de Qué-ec 23,546 lbs. de dindons dont 91% furent lassés No. 1. Ceci prouve l'amélioration ui s'est produite par l'introduction de re-roducteurs de sang étranger.

Enseignement par l'Imprimé

Outre les nombreux articles traitant d'avi-ulture fournis à diverses revues et aux jour-aux, les bulletins et circulaires ci-dessous nt été édités par le Service de l'Aviculture.

irculaires:

os. 3—"La poule couveuse et ses poussins".
7—"Alimentation économique des troupeaux de volailles".
11—"Engraissement de la volaille".
12—"Production des oeufs en hiver".
15—"La diarrhée chez les poussins".
17—"Production des chapons".
26—"Comment économiser les grains au poulailler".
42—"Sélection des troupeaux de volailles".

lletins:

os. 4—"Vingt années de pratique et d'expérimentation à la basse-cour" (éditions 1914-16-23).
5—"Engraissement et préparation de la volaille pour le marché".
35—"Indicateur des éleveurs de volailles de la Province" (éditions 1917-19-24).
54—"Poultry raising in Quebec in war time".
55—"Elevage de la volaille dans les villes et villages" (3 éditions).
57—"Efficient poultry production in war time".
74—"Engraissement et préparation de la volaille pour le marché" (2 éditions).
75—"Education artificielle des poussins"
83—"L'élevage des dindons".
84—"L'élevage des oies et canards".

Tableau synoptique des maladies de volailles les plus communes, Plans agrandis de poulaillers pour 50, 100 et 200 poules, et plan d'éleveuse-colonie pour 500 poussins.

Réformes et Améliorations principales obtenues depuis douze ans.

1—Essai, introduction et acceptation dans tous les comtés de la Province, des poulaillers "autonomes", dits poulaillers froids.

2—Amélioration des troupeaux et augmentation de la production par l'introduction de sang de race pure.

3—Alimentation plus rationnelle, grâce aux cultures spéciales et à l'usage de broyeurs d'os.

4—Transformation des expositions avicoles par l'octroi de primes "prix d'expositions" favorisant tout spécialement les races et les sujets d'utilité, les volailles les plus productives.

5—Production des oeufs à l'automme et en hiver, grâce à un élevage rationnel.

6—Développement de l'incubation et de l'élevage artificiels, qui favorisent l'élevage hâtif, sans lequel la production des oeufs à l'automne et en hiver est quasi impossible.

7—Vente des oeufs et volailles en coopération; paiement selon la qualité.

8—Engraissement méthodique et préparation convenable de la volaille pour le marché.

9—Régénération de l'élevage du dindon par l'introduction de sang étranger et de race pure.

10—Augmention du nombre d'oiseaux de basse-cour dans la Province de 5,-53,038 à 7,354,000, soit 42.7%. (Statistiques fédérales).

ACTIVITES DES SECTIONS

SECTION DE QUEBEC

Reunion du 5 Avril 1927

amedi après-midi, une quarantaine d'agromes se réunissaient au restaurant Kerhulu. On remarquait à ce diner-causerie l'invité d'honneur M. F.-T. Wahlen, docteur ès sciences naturelles, M. Sainte-Marie, président des agronomes du bas de Québec, plus-

ieurs membres de cette section, et un grand nombre de la région de Québec.

Le conférencier, présenté avec chaleur, par le président M. Jean-Charles Magnan, nous parle de la Suisse, son pays d'origine. "Ce peuple, dit-il, nous donne une belle leçon d'attachement au sol. L'union coopérative suisse comprend 200,000 membres. La partie montagneuse, et par conséquent inculte, occupant les 2-3 de la superficie totale, les paysans suisses ont vite appris la culture méthodique, intensive, grâce à leur notions agricoles que les jeunes peuvent prendre facilement à 35 écoles moyennes d'agriculture. Aussi en suisse peut en vivre sur une terre de 14 acres.

La vie sociale et esthétique est très développée. Les fêtes paroissiales sont très en vogue. Les constructions se font d'après un plan, s'harmonisant avec le magnifique cadre naturel des montagnes et lacs du pays. Trois langues sont officielles, et il y a une foule de dialectes. Pourtant les Suisses s'entendent bien, et les touristes aiment la Suisse parce qu'elle tient à conserver son cachet si pittoresque.

Monsieur Pépin, Docteur ès Sciences, remercie le conférencier en termes élogieux.

Et les agronomes passent an laboratoire des semences, font leurs élections et discutent leurs questions de régie interne.

Monsieur Antonio Mathieu, ancien vice-président, devient président, monsieur Auguste Pépin est nommé vice-président, et monsieur Adrien Desautels, secrétaire.

SECTION DE MONTREAL

An déjeuner causerie du 9 avril, qui a eu lieu, comme d'habitude, au Cercle Universitaire de Montréal, monsieur Henri Bois, professeur d'Economie rurale à l'Institut Agricole d'Oka, a traité du "Crédit agricole". Le conférencier développa son sujet avec la clarté, la précision et le tranchant qu'on lui connait. Après les définitions générales, il exposa les différents genres de crédit en usage:

1—Crédit à court terme.
2—Crédit à moyen terme.
3—Crédit à long terme.

et leur objet respectif.

Ensuite fut posée la question de savoir quel est le système d'organisation de crédit agricole qui donne les meilleurs résultats, Gouvernemental ou Coopératif.

Monsieur Bois se prononça nettement e faveur du Crédit Coopératif, qui a fait se preuves depuis longtemps dans beaucoup d pays d'Europe, tels que l'Allemagne, l France, l'Italie, le Danemark, la Belgique, etc

Dans la province de Québec il existe auss sous forme de 150 Caisses Populaires, qui on fait un pas décisif dans la bonne voie en s constituant en unions régionales.

Monsieur Raphael Rousseau, vice-présiden de la Section de Montréal, adressa des reme ciements au conférencier, de la part des trent et quelques convives qui assistaient au dé jeuner-causerie.

Le travail de Monsieur Henri Bois, don nous n'avons fait qu'indiquer la divisio sera publié in extenso.

Notons parmi les assistants n'appartenan pas à la section de Montréal, M. Adrien De autels, de la section de Québec, qui éta accompagné de monsieur La Rochelle, secr taire général de l'Association Catholique d la Jeunesse Canadienne.

A la fin de la séance il fut procédé a renouvellement du bureau de la Section d Montréal pour l'année 1927-28. Messieu H. M. Nagant et Gustave Toupin furent re pectivement choisis comme président et secr taire; à monsieur Alfred Leclerc échut vice-président, en remplacement de M. Rap ael Rousseau qui avait décliné le renouvell ment de son mandat.

NOUVELLES DE NOS MEMBRES

C'est certainement avec plaisir et fierté qu les membres Canadiens-français de la C.S.T.A auront appris la nouvelle de l'élection d monsieur L. Ph. Roy, Chef du Service d Grande Culture au Département d'Agricu ture de Québec, en qualité de Président gé éral de notre association professionnell Cette élection s'est faite, ainsi qu'on a pu constater, par acclamation.

Voici, dans sa spontanéité, un bel hom mage rendu à la valeur personnelle de not confrère L. Ph. Roy, par les techniciens ag coles des deux grandes races qui se partage le Canada.

On nous anonnce le mariage de monsie Alfred Savoie, B.S.A., Inspecteur des Ferm de Démonstration du Département de l'Ag culture de la province de Quebec, avec mad moiselle Rose Dionne. La bénédiction nu tiale a eu lieu en la basilique de Québec, 18 avril.

IN MEMORIAM

Tous les anciens de l'Institut Agricole, d'Oka, de même que beaucoup d'autres techniciens agricoles qui l'ont connu, auront une pensée émue à la mémoire du Révérent Père Athanase, décédé, après une courte maladie, le 14 avril dernier, à la Trappe d'Oka. Le défunt qui remplissait les fonctions de cellérier au monastère d'Oka, enseignait les cours thériques et pratiques de culture maraîchère, matière dans laquelle il possédait une compétence reconnue, à l'Institut Agricole d'Oka.

On sait aussi qu'à une grande activité, le R. P. Athanase joignait beaucoup de bonté de coeur et une réelle bonhommie.

ENCORE LE CALCAIRE MAGNESIEN

Ajoutons, à toutes les autres, une nouvelle affirmation du caractère inoffensif des calcaires magnésiens employés comme amendement des sols. Elle se trouve dans le bulletin 313, du département d'agriculture d'Ontario, "Soil acidity and liming", publié en décembre 1925, et signé par R. Harcourt, professeur de Chimie, S. Waterman, soil research chemist et G. H. Ruhnke, soil surveyer. Voici la traduction du paragraphe traitant de la question: "Autrefois les cultivateurs qui achetaient de la pierre à chaux s'inquiétaient beaucoup de l'affirmation que la dolomie ou pierre à chaux magnésienne avait une action délétère sur les récoltes. Si on peut regretter que des expériences n'aient pas été entreprises en cette province dans le but de recueillir des renseignements locaux concernant cette question, nous pouvons cependant accepter en toute sécurité les résultats obtenus partout aux Etats-Unis. Dans la majorité des états on fait usage de dolomie broyée, et dans certains cas il en a été fait usage pendant de nombreuses années, sans mauvais effet. Une grande partie du sol de l'Ontario repose sur de la dolomie, et la pierre calcaire qui s'y trouve disséminée est de la dolomie. Ce sol a été cultivé depuis au-delà de cent ans et il n'a pas été constaté d'action nuisible. Le département de chimie du collège d'agriculture d'Ontario a établi des expériences nombreuses sur toute la surface de l'ouest de l'Ontario avec ce genre de pierre à chaux, durant les cinq dernières années. Si le calcaire magnésien était nocif, on devrait naturellement supposer que les récoltes produites à Guelph, où tout le calcaire est dolomitique, seraient de qualité inférieure à celles obtenues aux environs de Beachville, où la pierre est constituée de carbonate de chaux pur. Or, nous n'avons pu constater ce fait. Nous savons cependant que la chaux, vive ou hydratée, fabriquée avec de la pierre contenant un pourcentage élevé de magnésium ne fournit pas un mortier à prise rapide comme celle faite avec du carbonate de calcium. L'hydroxyde de magnésium n'absorbe donc pas si facilement le CO^2 que l'hydroxyde de chaux, et de ce fait a une tendance à conserver au sol une réaction alcaline qui peut causer du tort aux plantes. C'est ce qui se produit lorsqu'on applique de fortes doses de chaux vive ou hydratée, renfermant un pourcentage élevé de magnésium. Mais cela ne peut être le cas lorsque la forme carbonatée est appliquée à l'état de calcaire broyé, et c'est pourquoi nous ne faisons pas de différence entre la calcite ou pierre à chaux calcique et le mélange de carbonate de calcium et de magnésium qui constitue de la dolomie ou calcaire magnésien.

H. M. N.

EXPERIENCES AVEC ENGRAIS CHIMIQUES DANS L'ONTARIO

Le bulletin No. 321, du Département d'Agriculture d'Ontario, intitulé: "LIME AND PHOSPHATE," nous donne un rapport très intéressant des expériences avec engrais chimiques, principalement la chaux et les phosphates, conduites depuis quelques années dans cette province. Il y a surtout à noter les résultats remarquables obtenus avec l'emploi du superphosphate, à l'exclusion d'autres engrais, pour bon nombre de récoltes. Ils confirment pour l'Ontario, le principe généralement reconnu que l'acide phosphorique sous une forme facilement assimilable est l'élément qui se trouve au minimum par rapport aux besoins de beaucoup de produits de la culture générale. Ce que nous voulons faire ressortir, dit le professeur Harcourt, dans un résumé des expériences publié dans "FARMER'S ADVOCATE", du 10 mars dernier, c'est qu'il suffit, peut-être ou probablement, d'appliquer des phosphates seulement pour le blé d'automne et les productions de la culture générale, sauf les pommes de terre, la où les légumineuses entrent dans la rotation et où les récoltes sont consomées par le bétail.

Mais il est tout aussi vrai que les mélanges ou engrais complets sont nécessaires aux cultures plus spécialisées ou plus intensives.

Parmi les résultats généraux, notons que l'augmentation moyenne du rendement constatée pour les parcelles de blé d'automne ayant reçu du superphosphate et un amendement calcaire fut de 54.6% comparativement aux parcelles témoins, en 1923.

Le trèfle, semé avec le blé d'automne donna des surplus de rendement se chiffrant à 60.8% en 1924, 36% en 1925 et 28.3% en 1926, ce qui démontre bien l'effet considérable produit par l'action résiduelle de l'acide phosphorique appliqué au blé.

Les expériences mentionnées plus haut furent faites sur trois fermes choisies dans huit comtés différents dont le sol était en majeure partie acide. Elles débutèrent à l'automne 1922, et le superphosphate fut appliqué conjointement avec des amendements calcaires.

L'extension de mêmes expériences à 24 comtés, fournit une moyenne d'augmentatio de rendement égale à 42% de blé. Si o tient compte, dit le professeur Harcourt, qu l'Ontario cultive 800,000 acres de blé, dor nant un rendement moyen de 24 boisseaux l'acre, la généralisation de l'emploi du supe phosphate dans la production du blé de province donnerait un surplus de 7,000,0C de boisseaux, valant sept millions de dollar Après estimation du coût des engrais, évalu à $4,000,000.00, il resterait un bénéfice c $3,000,000.00 pour les producteurs de b d'Ontario, sans compter la valeur du foin o trèfle produit les années suivantes, par l'eff résiduel du superphosphate.

Ne serait-il pas utile d'imiter dans province de Québec le travail expériment conduit avec engrais chimiques dans l'On tario?

H.M.N.

Concerning the C.S.T.A.

ELECTION RESULTS

Following are the results of the Dominion Elections which were conducted by mailed ballot during the month of April:—

President—L. P. Roy, Dept. of Agriculture, Quebec. (Elected by acclamation).

Vice-presidents:—E. S. Archibald, Central Experimental Farm, Ottawa, Ont.; A. T. Charron, Asst. Deputy Minister of Agriculture, Ottawa, Ont.

Honorary Secretary—L. H. Newman, Central Experimental Farm, Ottawa. (Re-elected)

There were 643 ballots received. The newly elected officers will assume their respective duties on June 1st, 1927.

APPLICATIONS FOR MEMBERSHIP

The following applications for regular membership have been received since April 1st:

Clarke, S. E. (Minnesota, 1927, Ph.D.) Swift Current, Sask.

Haslam, R. J. (McGill, 1925, B.S.A.) Ottawa, Ont.

Waterman, S. (Toronto, 1921, B.S.A.) Toronto, Ont.

CORRECTION

In the list of new members which w printed on page 319 of the April issue, M G. M. Stirrett was credited with the degr of Ph.D. from Minnesota. He has draw our attention to the fact that his thesis f this degree has yet to be completed.

CHANGES IN LIST OF MEMBERS

The following changes should be made the List of Members which was mailed to a members on April 2nd:—

Chagnon, S.J., Dept. of Agriculture, Quebe P.Q.

Cox, K., Experimental Farm, Nappan, N.S

Dumais, A., St. Antonin, P.Q.

Duval, L., 529 Sherbrooke St. East, Montrea P.Q.

Flewelling, B., Bridgewater, N.S.

Lavoie, C.H., Experimental Station, La Ferm P.Q.

Lemieux, O.A., Ontario Agricultural Colleg Guelph, Ont.

Limoges, D., Vaudreuil, P.Q.

Tarr, H.L.A., 240 Tenth St. East, North Va couver, B.C.

Simard, Jules, Dominion Seed Branch, Qu bec, P.Q.

Some Applications of Biometry to Agronomic Experiments.*

C. H. GOULDEN

Cereal Specialist, Dominion Rust Research Laboratory, Winnipeg, Man.

Introduction

On this continent there has been some con-troversy among agronomic workers over a rocess of statistical analysis commonly re-erred to as "Student's method". However ie recent elementary discussion of statistical iethods applied to agronomic data by "Stud-nt" (10) clears up many of the debatable oints and it is the purpose of this paper ierely to emphasize these and to demonstrate s much as possible by means of actual or ieoretical examples.

Calculations of Probability

It would seem desirable first to make a ief statement of some of the fundamental cts upon which most calculations of prob-ility are based.

When a large number of variates are classi-ed in the form commonly known as a fre-iency distribution the results can, in most ses, be well represented by what is known the normal curve of variability. This rve may be easily calculated for any dis-ibution when the mean, standard devia-n, and total number of variates are known. r methods of calculation we may refer to rsyth (2). In Figure 1 the histogram repre-its graphically the actual frequency dis-

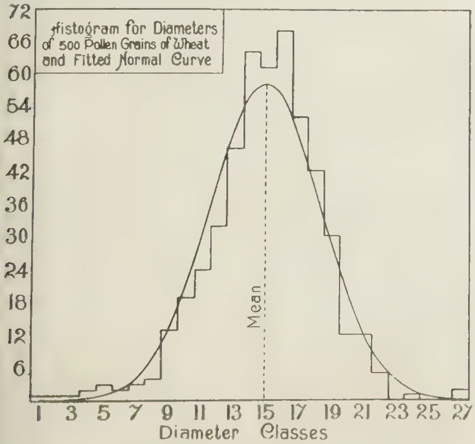


Figure 1

tribution of the diameters of 500 pollen grains of wheat. The smooth curve is the theoretical normal curve which has been calculated from the actual distribution. It must be kept in mind that the normal curve represents, not the actual random sample studied but the theoretical infinitely large population from which the sample was drawn.

In Figure 2 a normal curve is shown divided in terms of a constant known as the probable error (P.E.), and is explanatory of the principle upon which the calculation of probabilities is based, when samples are being dealt with which may reasonably be represented by a normal curve of variability. On the basis of a theoretical population of 1000 which is of course represented by the total

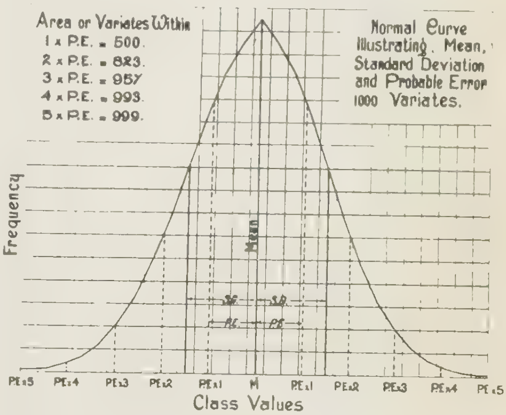


Figure 2

area of the curve, the number of variates are given which fall within the areas delimited by vertical lines drawn at distances from the mean of 1, 2, 3, 4, and 5, times the probable error. Consequently when any individual is selected *at random* from such a population it is pos-

*Given as an elementary lecture on Biometry Applied to Agronomic Problems at the 1926 meetings of the Western Canadian Society of Agronomy, and revised for publication. Contribution from the Division of Cereals, Experimental Farms Branch, Department of Agriculture, Ottawa, Canada.

The writer is indebted to Dr. H. K. Hayes of University Farm, St. Paul, for a critical reading of the manuscript.

sible to calculate the probability or odds of its falling within certain limits. The odds that any particular individual selected at random falls within 1 x P.E., 2 x P.E., etc., are as follows:—

1 x P.E.	1:1
2 x P.E.	4.64:1
3 x P.E.	22.26:1
4 x P.E.	142.3:1
5 x P.E.	1350:1

Considered from another standpoint it may be stated that, if an individual variate is drawn at random from this population, the odds are 1:1 that it will not deviate from the arithmetic mean by more than 1 x P.E., 4.64:1 that it will not deviate more than 2 x P.E., and so forth.

It should be observed in passing that in the curve, the P.E. is shown in relation to the standard deviation (S.D.), from which it is calculated. This relation is constant and is expressed by the probable error = .6745 x S.D. In place of the P.E. we may use the S.D. if we so desire. In fact there is nothing to be gained by using the P.E. in preference to the S.D. when the necessary probability tables are available.

We see therefore, that the probability of the occurrence of a given deviation D, when an individual variate is selected at random from a *normally distributed population,* may be determined from the ratio D/P.E. or D/S.D. Consequently when applying this test we must be reasonably certain of two points, (1) that the distribution of variates is approximately normal and (2) that the calculated S.D. is an accurate estimate of the true standard deviation of the infinitely large population from which the sample is drawn. Regarding the type of the distribution of the population, it is usually safe to assume a reasonably close approach to normality with statistical material obtained from ordinary agronomic experiments, so that in this connection small samples will not often lead us far astray. As to the accuracy of the S.D. calculated from small samples, Fisher (1) points out that it is desirable to designate such a S.D. by the symbol S, reserving the usual symbol σ to represent only the actual or true standard deviation. This is rather a useful idea as it helps one to fix in mind a point which is fundamental in all statistical work with samples which are not large enough to give a really accurate estimate o the S.D.

From the approximately normally distri buted population of diameters of polle grains shown graphically in Figure 1, sample of 10 was drawn at random and th histogram of this sample is shown in Figur 3. The results from such a sample will no allow one to conclude that the populatio sampled is normally distributed, but as point ed out above the actual distribution is usua ly sufficiently normal so that we are not likel to be led into serious error.

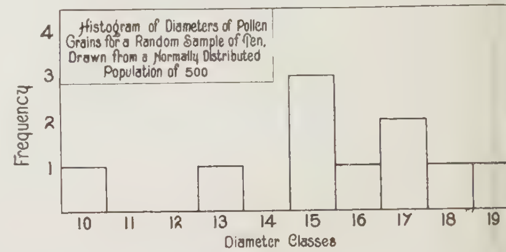


Figure 3

In order to demonstrate the variabilit of the estimates of the S.D. for small samp les, twenty samples of four variates wer drawn at random from the population of 50 shown in Figure 1 and the S.D. calculate for each. The standard deviations are a follows, 3.55, 1.79, 0.85, 1.48, 2.38, 2.8 2.16, 3.54, 2.12, 3.21, 2.22, 2.42, 2.22, 3.0 2.16, 2.61, 1.43, 2.84, 1.77, and 4.24. Th calculated S.D. for the entire population wa 3.45 and since the population was reasonabl large this may be regarded as being ver close to the true value. The estimated value of the S.D. vary appreciably from the tru value and this must seriously affect its relia bility in tests of significance.

Regarding calculations of probability fro small samples, aside from the high variabi ity of the calculated biometrical constan such as the standard deviation, another fa tor enters in which introduces a mathematic error. In order to emphasize this point w cannot do better than quote from Fisher (1 who presents the situation in a very clea and concise manner. "If x (for example th mean of a sample) is a value with norm distribution and σ is the true standard erro then the probability that x/σ exceeds an specified value may be obtained from th appropriate table of the normal distrib tio; but if we do not know σ but

ts place have ς an estimate of the value f σ, the distribution required will be that f x/ς and this is not normal. The true alue has been divided by a factor ς/σ which ntroduces an error."

Student's Method and Small Samples

The above principles were clearly pointed ut by "Student (8) in 1908 and led to the evelopment of "Student's" Tables which are dapted primarily to calculations of probabil-y from small samples. Fuller tables have nce been published by Student (9), and ove (5) has prepared tables in which the lds have been calculated from the values P for all of the necessary values of x/ς, Z as this ratio is designated by "Student". should be made perfectly clear at this oint that the use of these tables does not ake tests from small samples as reliable those from larger ones. They simply eli-inate the mathematical error which enters when tables of the normal distribution are ed to interpret the results from small mples.

The application of "Student's" Tables was st demonstrated by "Student" using some ta on the sleeping effect of two drugs on different patients. At different times each the patients was drugged and the time at each slept was recorded. The results re then set up as follows:

Patient	Additional Hours of Sleep (L-D)
1	+ 1.2
2	+ 2.4
3	+ 1.3
4	+ 1.3
5	+ 0
6	+ 1.0
7	+ 1.8
8	+ 0.8
9	+ 4.6
10	+ 1.4
Mean =	1.58
S.D. =	1.17

average additional hours of sleep induc-by drug L over D is 1.58. The S.D. of the gains of L over D is 1.17 and the probable error will be 1.17x.6745=.7892. This S.D. it must be remembered, is the S.D. of the differences between the paired values of L and D which are not given in the table. We can therefore, represent it by σ_{L-D} and if we had calculated the S.D. of L and D separately we could have obtained σ_{L-D} by the following well known formula:

$$\sigma_{L-D} = \sqrt{\sigma_L^2 + \sigma_D^2 - 2\, r_{LD}\, \sigma_L\, \sigma_D}$$

The reason why "Student" did not adopt this latter method of finding σ_{L-D} is quite obvious. By so doing he avoided some laborious calculation and arrived at an identical result. The method of taking differences between paired values directly was not original with "Student" and on no account should this be confused with his real contribution to statistical knowledge.

In the above case the ratio M_{L-D}/σ_{L-D} or Z, is 1.58/1.17=1.35. Entering "Student's" tables at Z=1.35 and under the column headed n=10, we find that a value of .99854 is given for P. The odds of significance are therefore $\dfrac{.99854}{1.000 - .99854}$:1 or 666 to 1 that the L compound is a better soporific than D.

Let us interpret these results by means of the tables of the normal distribution.* The S.D. of the mean difference $\sigma_{L-D}/\sqrt{n}$ is 0.37. The ratio 1.58/.37 gives 4.27. This gives a value of P of .9999902 and the odds of significance are $\dfrac{.9999902}{1.000000 - .9999902}$:1 or 51019: 1. The normal curve gives odds which are too high. This example demonstrates fairly well the tendency for the odds to be kept down when using "Student's" Tables to interpret the results from small samples.

Before proceeding further let us apply the same method of analysis to an actual example of variety yields. In Table 1 the yields are given for two wheat varieties grown in the co-operative tests conducted from the Brandon Experimental Farm during 1926 and the results analyzed according to "Student's" method.

*Pearson, K. "Tables for Statisticians and Biometricians" Cambridge University Press. Second Edition,1924.

Table I. Analysis by Student's method of the yields in bushels per acre of wheat varieties grown in 1926 in co-operative tests conducted from the Brandon Experimental Farm*

A	B	A–B	$(A–B)^2$
64.1	62.9	1.2	1.44
32.4	12.8	19.6	384.16
46.7	55.1	–8.4	70.56
33.3	27.8	5.5	30.25
41.5	37.9	3.6	12.96
53.4	51.1	2.3	5.29
49.9	31.7	18.2	331.24
43.9	42.2	1.7	2.89
53.6	28.4	25.2	635.04
53.9	52.0	1.9	3.61
53.9	32.1	21.8	475.24
36.1	30.4	5.7	32.49
47.1	30.3	16.8	282.24
54.5	57.6	–3.1	9.61
76.4	56.2	20.2	408.04
$M_A = 49.38$	$M_B = 40.57$	$M_{A-B} = 8.81$	$M_{(A-B)^2} = 179.00$

$$M_{A-B} = 8.81$$

$$\sigma_{A-B} = \sqrt{\frac{S(A-B)^2}{n}} = 10.07$$

$$Z = .87$$

$$P = .9970 \quad \text{Odds} = 332:1$$

The odds here are 332:1 that A is a better yielding variety than B under conditions such as existed in 1926. Using tables of the normal distribution, odds of 1430:1 are obtained. This example again demonstrates that lower odds are in general obtained when "Student's" tables are used.

At this point it would be well to refer again to the method of taking differences directly when paired values are being dealt with. This simplifies the calculation of the S.D. of a difference but makes no difference whatever to the final result. When the differences between the paired values are not taken directly the value of the S.D. of the differences must be obtained by the formula given above which includes the correlation coefficient. Usually when the values are paired the correlation coefficient is significant and must not be neglected unless there is good reason to believe that its influence on the result will be negligible.

The example used of the comparison of the two varieties A and B will serve very well to illustrate the point in question. If the correlation is neglected our formula becomes $\sigma_{A-B} = \sqrt{\sigma_A^2 + \sigma_B^2}$ which if used in this case gives a value of 17.91 for σ_{A-B}, where the correct value obtained by taking the d ferences directly or by the complete formu is 10.07. Using the value of 17.91 and ca culating the odds we find that they are 21.3 that A is a better yielder than B. The co relation coefficient r_{AB} in this case is .70 and evidently it should not be disregarde

Criticisms of Student's Method

Some criticisms of the so-called "Student' method as applied to agronomic data m now be considered.

Salmon (7) states that two main cri cisms may be offered. "The first relates those fertilizer and tillage experiments which a given plot or tract of land receiv the same treatment year after year. The s cond is more general and is related to t fact that "Student's" method measures t uniformity or consistency of a gain for given treatment or variety regardless whether the variable gains are due to e

*These data furnished by Mr. S. J. Sigfusson of t Brandon Experimental Farm. The method of analy used here is not strictly correct in that each yield given is the average yield from two plots. The ample is used here however, simply to demonstrate method and the averages employed in order to red the size of the table.

erimental errors or to a differential response ɔ environmental factors". To these criti-isms it is difficult to make a direct answer s they are evidently directed against the ıethod of taking differences between paired alues and have no bearing whatever on Student's" real contribution regarding the orrect interpretation of results by the use " "Student's" Tables. Salmon's criticisms erefore, apply to any process of statistical ıalysis for determining the significance of mean difference between paired values. In ı experiment in which given plots of land ceive the same treatment year after year, there is any basic difference in the fertility the plots it is evident that statistical analy· will reflect these differences plus those e to treatment and if one wishes to separate ese effects the experiment must be planned cordingly.

Regarding Salmon's statement that "Stud·'s" method measures the consistency of a in, etc., the writer is of the opinion that should have been made clear that this es not apply more particularly to the thod of taking differences between paired ues than to any other method. We ob-ı the same value for the standard deviation a difference whether we determine it ectly or by determining first the standard iations of the two series and then ap-ing the complete formula. As to the nt made that "Student's" method measures consistency of gains regardless of whether are due to experimental errors or to a erential response to environmental fac-, it must be emphasized again that the ring in of such experimental errors is due ncorrect planning of the experiment with ird to the conditions of random sampling. en results are viewed in which we feel onably certain that experimental errors present which will affect the interpreta-, we are not justified in the first place in ying any kind of statistical analysis un-we have some means of weighing the ex-mental error and allowing for it. Since errors creep into many experiments, this not mean that statistical methods are less; because the same error will affect conclusions if we discard all processes athematical analysis and follow the old ice of merely inspecting our results. This e service at least which statistical method lone for us. It has pointed out clearly and definitely where the fundamental errors in our experimental technique are to be found.

In a recent paper Sachs (6) adds further to Salmon's criticisms of "Student's" method. Some hypothetical data for drainage experiments are given from which it is evident that in wet years tiling results in a very marked increase in yield while in dry years there is little or no increase. When data for a period of six years, three wet and three dry, are analyzed by "Student's" method it is found that the odds are only 19:1 in favor of the drained plots. Sach's states that "the difficulty here is that "Student's" method does not take into account the fact that the years in which large differences were obtained were vey wet, while the others were very dry and there was no need for drainage". This is an excellent example for the need of a clear understanding as to the exact meaning of any statistical interpretation. The odds of 19:1 obtained in this analysis mean simply that if the experiment was repeated 20 times on the same soil and with identical climatic conditions throughout the periods of six years, in 19 cases out of 20 the mean gain would not be exceeded by more than Z times the standard deviation. This is all of the information that any analysis can be expected to furnish and only allows us to draw definite conclusions regarding variety tests, fertilizer treatments, the value of drainage, and so forth when we are reasonably certain that the results of our experiments have been drawn from a *truly random sample* of the soil and climatic conditions. Sachs states further—"Because the tile was of little or no value in the dry years but of real benefit during the wet years, must it be concluded that the tile has not benefited the soil?" It is too much to expect a statistical method to consider all of the economic factors entering into the value of a result and there is positively no reason why it should be expected to answer this question. Information of great value from the standpoint of the economy in using tile might be derived from a consideration of the results for individual seasons. If the plots in such an experiment were paired and *sufficiently replicated*, "Student's" method could be applied to the results for each year. It would probably be quite easy to demonstrate the statistical significance of increased yields due to tiling in wet years and that no significant increases would be

obtained in dry years. Further than this statistical and experimental methods cannot go. The economics of the question must be worked out on the basis of the information which the analysis gives for the particular conditions under which the experiment was conducted.

Statistical methods in agronomy will be of great value if they assist in bringing more clearly to the attention of experimentalists only one of the points mentioned above; namely that the conducting of experiments over a period of years is merely the taking of a random sample of the climatic conditions affecting the results of the experiment. If we can be certain that the meteorological data for the period of a given test indicate abnormality in the seasons it becomes evident immediately that conclusions must be carefully drawn. The same applies to the abnormal prevalence or absence of disease epidemics. Owing to the uncertainty of climatic conditions, especially in Western Canada, this point must be given very careful consideration. After a given test over a period of years if we cannot be reasonably certain that the conditions which obtained are going to be duplicated, our tests do not mean very much.

Returning again to Salmon's criticism regarding fertilizer experiments, the obvious manner in which to conduct such an experiment is to replicate as frequently as possible, pair up the plots, take the differences directly between the yields of the paired plots, and interpret the results by using "Student's" tables, or if the number of comparisons are great enough, by the use of probability tables based on the normal curve. In the experiment cited by Salmon only two plots were used and "Student" (10) comments as follows. "It is only one case from which, of course, defiunite conclusion cannot be drawn either by "Student's" method or any other method. If however, ten repetitions had been made with an arrangement of the plots which could be considered random, the population sampled would have been that of "all similar soils" and the error introduced by soil heterogeneity would have been weighed and allowed for by the use of the tables."

Let us draw up a theoretical case for a tillage experiment or variety test, indicating how the plots may be laid out and the data handled. The two treatments or varieties A and B are being compared *over a period* [of] *three years.* The following or some [very] similar arrangement of the plots might [be] used:

A	B	B	A	A	B	B	A

The results when set up at the end of [the] three year period may be as given in Tabl[e 2].

Table 2. Assumed individual plot yields [in] bushels per acre for two wheat varie[ties] over a period of three years.

Year	Individual Plot Yields A	B	Yearly Avera[ge] A	[B]
	35.4	33.7		
	37.9	38.0		
1	29.3	24.3	33.70	31[illegible]
	22.2	29.1		
	42.4	41.8		
	35.3	30.5		
2	30.9	32.2	34.00	32[illegible]
	27.4	24.3		
	27.1	26.2		
	29.4	25.3		
3	32.4	36.7	28.55	28[illegible]
	25.3	25.2		

The data may be analyzed conveniently [as] in Table 3. We obtain a value of 2.6176 [for] σ_{A-B} in this case and, using "Student's" T[ab]les to interpret the ratio, Z = .56, we ob[tain] odds of 19.2:1.

Table 3. Analysis of Results by Stude[nt's] Method.

A	B	A–B	(A–B[)²]
35.4	33.7	1.7	2.8[illegible]
37.9	38.0	–0.1	.0[illegible]
29.3	24.3	5.0	25.0[illegible]
22.2	29.1	3.1	9.6[illegible]
42.4	41.8	0.6	.3[illegible]
35.3	30.5	4.8	23.0[illegible]
30.9	32.2	–1.3	1.6[illegible]
27.4	24.3	3.1	9.6[illegible]
27.1	26.2	0.9	.8[illegible]
29.4	25.3	4.1	16.8[illegible]
32.4	36.7	–4.3	18.4[illegible]
25.3	25.2	0.1	.0[illegible]
	Total =	17.7	108.3[illegible]

$$\text{Mean difference } (M_{A-B}) = \frac{17.7}{12} = 1.47[illegible]$$

andard deviation of differences—

$$\sigma_{A\text{-}B} = \sqrt{\frac{108.33-(1.475)^2}{12}} = 2.6176$$

$$= \frac{1.475}{2.618} = .56 \qquad \text{Odds} = 19.2:1$$

It should be emphasized at this point that an example such as the one given the corct method of procedure if soil variability to be taken into account is to consider the elds from individual pairs of plots. One ght wish possibly in such an analysis to ıdy seasonal variability only, in which case ısonal averages should be used. A comrison of this kind however is rarely of ıch value as its reliability is always inenced by the amount of soil variability. e use of seasonal averages leaves the fac· of soil variability an unknown quantity d it cannot lead therefore to a satisfactory ıclusion as to the significance of the results.

If in the example above the averages are d and the results analyzed as in Table 3, obtain odds of 13:1. That these do not fer appreciably from those obtained by previous method is of course to be exted under the circumstances as there is a h correlation between the paired values l there is not a great deal of difference been the variability for the different seas. The differences between the paired ts, however, are less variable in the third r than in the other two and this is suffiıt to account for the slightly higher odds ained by the method of analysis which inves all of the paired comparisons.

Hayes (3) makes a comparison of two vares of barley over a period of five years "Student's" method using seasonal avers only, and makes the statement "that a bable error which measures soil heteroeity is more desirable than "Student's" ıparison for results of this nature." The ter is in complete agreement with this vpoint if it is not possible to compare indual plot yields as well as seasonal ages; but this is seldom true unless only plot of each variety is grown, and the ılts are then useless for the purpose of asonal comparison. In all variety tests which the plots are replicated, when maka comparison of any two varieties we have two plots, one of each variety in each replicate and these may be used as paired comparisons in applying "Student's" method. The plots considered may not be adjacent, in fact they may be so far apart that there is no correlation between the yields, but this is all the more reason for considering them as pairs *when applying "Student's" method*, as soil heterogeneity becomes here a very real factor in affecting the significance of a mean difference. If a large number of plots, say 10 of each variety, are used and the plots are adjacent, the correlation between the yields will be high and the average yield of each variety for the 10 plots will have a low probable error. Under these circumstances one may in analyzing the results *over a period of years*, apply "Student's" comparison to the seasonal averages only, without straying very far from an accurate result. As these conditions are reversed, however, especially with respect to the correlation between the yields of the paired plots, it becomes more and more necessary to use the yields of individual plots.

In connection with nursery trials in which a large number of strains and varieties are being tested over a period of years, there can be little question as to superiority of the method advocated by Hayes (3) for making comparisons by means of the probable errors of the averages, since it would be a very laborious process to make comparisons of all the varieties by "Student's" method. The point that the writer wishes to make however, is that there is no essential difference between the two methods for comparing any two varieties provided that in using "Student's" method the individual plot yields are considered and in using the probable error method the correlation between the yields of plots adjacent or approximately so, is taken into account.

Analysis of the Probable Error of Averages

It is interesting in this connection to analyse the method advocated by Hayes for comparing varieties over a period of years more closely. The probable error of the experiment is determined each year and when considering the results over a period of more than one year an average probable error is obtained by the formula

$$\frac{1}{N}\sqrt{a^2+b^2+\ldots+y^2}.$$

Where N=number of means averaged and a, b, ... y, are separate probable erors in percentage for the respective years. The formula is evidently derived, (see Hayes (3) page 9 for citation), from the general formula for the standard deviation of a series of observations consisting of two or more component series for which the means and standard deviations are known, Yule (10), If M be the mean of the entire series; M_1, M_2, ... M_y, the means of the component series; σ_1, σ_2, ... σ_3, the standard deviations of the component series; $d_1=M_1-M$, $d_2=M_2-M$, and $d_y=M_y-M$; N = the number of observations in the total of the series; and N_1, N_2, ... N_y, the numbers of observations in the component series, we have

$$N\sigma^2=N_1(\sigma_1^2+d_1^2)+N_2(\sigma_2^2+d_2^2)+\ldots+N_y(\sigma_y^2+d_y^2)$$

and if the number of observations in each series is the same—

$$\sigma^2=1/n(\sigma_1^2+d_1^2+\sigma_2^2+d_2^2+\ldots+\sigma_y^2+d_y^2)$$

where n=the number of component series. If the means of the component series are coincident the formula becomes

$$\sigma^2=1/n(\sigma_1^2+\sigma_2^2+\ldots+\sigma^2_y)$$

and $$\sigma/\sqrt{n}=1/n\sqrt{\sigma_1^2+\sigma_2^2+\ldots+\sigma^2_y}$$

This is the general formula used by Hayes with the exception that the probable errors or standard deviations as the case may be are put in percentage of their respective means. The use of this simplified formula does not assume that the means are coincident but the correction for the difference between the means is purposely omitted in order to eliminate the effect of seasonal variation in yield. Standard deviations for single varieties calculated in this way may therefore be used to calculate the standard deviation of a mean difference between any two varieties *without taking into consideration the seasonal correlation between the yields.* If the plots are paired however there will a soil correlation between the yields of paired plots and of course this will not taken into consideration. Hayes discus this latter point in some detail in the publi tion referred to above.

The hypothetical example given above a analyzed in Table 3 may be used to dem strate the similarity between "Student method and that of using the probable ror or standard deviation of a series of av ages. The standard deviation of a single c ference in this case=2.6176, therefore standard deviation of the mean differen will be $2.6176/\sqrt{12}=.756$. The steps nec sary in order to obtain a comparable sta ard deviation by the method of probable rors of averages are given in Table 4. Having obtained σ_A and σ_B for the three y averages we can determine $\sigma_{A-B}/\sqrt{n}$ if correlation between the paired yields of and B is known. This correlation must consider the concomitant seasonal variati in the yields as this has been eliminated the calculation of σ_A and σ_B as previou pointed out. This is accomplished by p ting all the yields of A and B as given Table 3 in percentage of their respect means for the entire period. The value r_{AB} in this case is .91 and using the comp formula for $\sigma_{A-B}/\sqrt{n}$ we reach a value .706. This is quite comparable with standard deviation obtained by Stude method (.756) as illustrated in Table 3, shows that the methods are fundamenta similar.

Another example may be used in wh there is no correlation between the pai yields. We will have approximately suc condition when a large number of varie are being tested and two plots in each re cate of the varieties being compared ar considerable distance apart. The exam

Table 4. Determination of the standard deviation of the mean difference from the sta dard deviations of the seasonal averages.

Year	$\sigma_A/\sqrt{4}$	Mean–A.	$\sigma_A/\sqrt{4}$ in %	$\sigma_B/\sqrt{4}$	Mean–B.	$\sigma_B/\sqrt{4}$ in %
1	1.6235	33.70	4.8190	2.5400	31.28	8.1202
2	2.8000	34.00	4.2353	2.1375	32.20	9.7453
3	1.3285	28.55	4.6550	2.4185	28.35	8.5326

Av. $\sigma_A=1.135$ in bus. Av. $\sigma_B=1.559$ in bus.

When $r_{AB}=.91$, $\sigma_{A-B}/\sqrt{n}=.706$

is hypothetical, the figures having been chosen such that the soil correlation is zero.

Table 5. Hypothetical yields in bushels per acre of two wheat varieties over a period of three years and determination of the significance of the mean difference by Student's method.

Year	A	B	A–B	$(A-B)^2$	Yearly Averages A	Yearly Averages B
	24	21	3	9		
1	23	22	1	1	24	22
	24	23	1	1		
	25	22	3	9		
	34	30	4	16		
2	31	32	–1	1	34	32
	34	34	0			
	37	32	5	25		
	44	39	5	25		
3	41	42	–1	1	44	42
	44	45	–1	1		
	47	42	5	25		

Means difference $(M_{A-B})=2.0$
Standard deviation of differences $(\sigma_{A-B})=2.345$
$P=.85$ Odds = 114:1

By the method of standard deviations of averages we have the results as in table 6.

From Table 5 we note that by "Student's" method $\sigma_{A-B} = 2.345$ therefore $\sigma_{A-B}/\sqrt{n} = 2.345/3.4641 = .6769$. Here again we have a very close agreement between the two methods.

From the similarity between these two methods we reach the conclusions that when a large number of varieties are being tested, the method involving the determination of the probable erorr of a series of averages is distinctly superior to making a comparison between the individual plot yields of all possible pairs of varieties by "Student's" method, since the latter method involves a considerable amount of calculation. Evidently the most convenient general method is to determine a probable error of the experiment each year in percent and use these at the end of a period of years to determine a probable error in percent of the series of averages. This probable error is then a single figure that may be applied to the average yields of all the varieties in the test. The only error which may enter in when using this method is that due to the correlation between the yields of adjacent plots and the extent of this error has been pointed out by Hayes (3). In the variety and strain tests carried on at the Dominion Rust Research Laboratory the varieties are placed in a different order in each replicate so that the error due to correlation entering into the determination of a probable error of a difference is relatively slight. This should not be taken to mean that correlation should necessarily be avoided in comparative tests. The test is most sensitive when the correlation is high and this should be definitely aimed at when the number of comparisons to be made is small but when the number of comparisons is large, a high correlation between the yields of all of the varieties is impossible and it therefore seems best to eliminate it altogether if this is possible.

Analysis of Results for Individual Seasons

As pointed out above relative to Sachs' criticism of "Student's" method applied to averages of yields over a period of years, the most valuable information from plot yields may be obtained from a study of the results for individual years. A study of the averages in a variety test is always desirable but such a study tends to cover up certain very important varietal characteristics just as the effect of tiling was partly covered up in the

Table 6. Determination of the standard deviation of the mean difference from the standard deviations of the seasonal averages.

Year	M_A	$\sigma_A/\sqrt{4}$	$\sigma_A/\sqrt{4}$ in %	M_B	$\sigma_B/\sqrt{4}$	$\sigma_B/\sqrt{4}$ in %
1	24	.3536	1.4732	22	.3536	1.6073
2	34	1.0607	3.1197	32	.7071	2.2097
3	44	1.0607	2.4107	42	1.0607	2.5255

Av. $\sigma_A=.4851$ bus. Av. $\sigma_B=.3969$ bus.
When $r_{AB}=0$, $\sigma_{A-B}/\sqrt{n}=.6268$

hypothetical experiment cited by Sachs. An accurate measure of the significance of differences in a single year's test is therefore extremely important and unless there are a large number of replications "Student's" method, as it is generally understood, will not give us a very reliable measure of the significance of the mean difference between any two varieties or treatments. Although the "Student's" tables are primarily adapted for small numbers this should not mislead us as to the general unreliability of small samples and when only three or four comparisons are available we cannot expect to reach very definite conclusions.

In variety tests it is possible to make quite accurate comparisons between any pair of varieties by means of a probable error of the experiment. Hayes (3) has shown how such a probable error may be obtained by what is usually known as the Deviation of the Mean Method, and that it agrees very well with a similar probable error calculated from a series of check plots distributed throughout the field. Kirk and Goulden (4) in a study of potato variety yields bring forward further evidence as to the reliability of a probable error calculated in this manner. Student (10) points out that the correct formula for such a probable error of an experiment is

$$P.E. = \pm .6745\sqrt{\frac{S(d)^2 n}{N(n-1)}}$$

where $d =$ deviation in bushels from the variety mean, $n =$ number of systematically distributed plots of each variety, and $N =$ the total number of deviations.

In making comparisons by means of the probable error of an experiment of results from one year's test it is of course desirable that the correlation between the yields of the plots of the two varieties being studied, be known. However, as pointed out by Hayes (3), the omission of this factor rarely introduces a serious error and as indicated in the discussion above the plots may be arranged in a random manner which makes the average correlation between all pairs of varieties very low.

SUMMARY

1. Calculations of probability for large samples assume a normal distribution of the variates and an accurate estimation of the standard deviation.

2. When only small samples are available it is usually safe to assume a normal distribution of the variates but the calculated standard deviation from such a sample is only a rough estimate of the true value. Consequently, tests of significance involving biometrical constants calculated from small samples are not as reliable as those from large samples.

3. "Student" has shown that the distribution of X (for example the mean of a sample) over ς (the estimated standard deviation) is not normal for small samples but approaches normality as the size of the sample is increased. Special tables were therefore developed for calculations of probability based on the true distribution for small samples.

4. "Student's" method as commonly referred to on this continent involves the determination of the standard deviation of a mean difference between a series of paired values by taking the differences directly between each pair. An identical value for the standard deviation of the mean difference is arrived at if the standard deviations of the two series of observations are first calculated and the values thus obtained used in conjunction with the correlation coefficient for the paired values to calculate the standard deviation of the mean difference.

5. Criticisms of "Student's" method as such, apply therefore to any method of determining the significance of a mean difference, between paired values, from its ratio to the standard deviation or probable error.

6. In applying "Student's" method to the analysis of the yields of two varieties over a period of years the individual plot yields should be arranged in pairs if possible as otherwise soil heterogeneity will not be taken into account. When used in this way results are obtained which are strictly comparable with any other correct method of statistical analysis.

7. The use of the probable error of a series of averages as advocated by Hayes (3) is analyzed and the desirability of this method for extensive variety and strain tests is pointed out.

8. In analyzing results for a single year's test only a few paired plot yields are usually available to which Student's method cannot be applied with any great degree of accuracy. For such comparisons it is desirable that a

accurate probable error of the experiment be calculated from the yields of all of the varieties grown.

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NOTE.

In a recent letter Dr. R. A. Fisher points out the necessity of taking into account the degrees of freedom in sorting out the various points to be considered in such an example as is given in Table 3, and of being guided by this in estimating the error. This point is discussed quite fully in Dr. Fisher's book and is of considerable importance when small numbers are being dealt with. In the above paper a discussion of this point was purposely avoided in order not to confuse the main issue, but perhaps unwisely, as it must necessarily be considered in most applications of statistical analysis to data from small samples.

In the example of Table 3, we may proceed as follows:

Let $S(d) = S(A-B)$, the summation of the mean differences between yields of paired plots; and $S(d^1) = S[(A-B)-\overline{A-B}]$, the summation of the deviations from the mean difference.

The results for the three years may then be arranged thus—

Year	S(d)	$S(d)^2$	$S(d^1)^2$	Degrees of Freedom
1	9.7	37.51	13.9875	3
2	7.2	34.70	21.7400	3
3	0.8	36.12	35.9600	3
Tot'l	17.7	108.33	71.5875	9

By this method the sum of squares for single plots =71.5875 whereas the sum of squares as calculated from Table 3 is

$$108.33 - \frac{(17.7)^2}{12} = 82.2225$$

The lower sum 71.5875 is due to the elimination of seasonal variation.

The sums of squares for all of the factors to be considered and the corresponding degrees of freedom may be outlined as follows:

Variation	Degrees of Freedom	Sum of Squares
In any year	9	71.5875
From year to year	2	10.6350
Total	11	82.2225

In Table 3 the data have been analyzed in a manner including the seasonal variation and are equivalent to—

Variance of single plot $= \frac{82.2225}{11} = 7.4748$

Variance of mean of 12 $= \frac{7.4748}{12} = 0.6229$

S.D. of mean $= \sqrt{.6229} = 0.7892$

$t = \frac{\text{mean}}{\text{S.D.}} = \frac{1.475}{.7892} = 1.869$

Odds $= 22.8 : 1$

However, Dr. Fisher points out that seasonal differences should be experimental fact rather than error so that the data would usually be analyzed—

Variance of single plot $= \frac{71.5875}{9} = 7.9542$

Variance of mean of 12 $= \frac{7.9542}{12} = 0.6629$

S.D. of mean $= \sqrt{.6629} = .8141$

$t = \frac{1.475}{.8141} = 1.812$

Odds $= 19.1 : 1$

To avoid confusion special mention shou be made of the use of t in place of "Stu ent's" Z. It was found that as n increa the scale of Z becomes very coarse and t the number in the sample was not the b number under which to enter the table, n–1, the number of degrees of freedom. Dr. Fisher's suggestion new tables w constructed by "Student" giving the dis bution of $t = Z\sqrt{n}$ where n is the number degrees of freedom, and by this means difficulties mentioned were overcome. F details may be obtained from Dr. Fishe book mentioned in the above paper and fr Fisher, R.A., "Applications of "Student distribution", and "Student", "New tab for testing the significance of observation both in Metron Vol. 5. No. 3, 1925. T odds as given in the examples used h were calculated from "Student's" tables the distribution of t.

BOOK REVIEWS

A LABORATORY GUIDE FOR QUANTITATIVE AGRICULTURAL CHEMISTRY. (Translated Title) by Georg Wieger. Published by Gebr. Borntraeger, Price 21: Mark.

This concise guide is the result of some fifteen years of teaching experience at the Swiss Polytechnic Institute in Zurich. It should be a very valuable book not only for the student but also for the teacher and the chemist engaged in the analysis of agricultural commodities. It is not designed, however, to replace hand-books, because rather than enumerating many methods, one or a few have been selected in each case and are discussed in considerable detail. For the student who is more deeply interested in the subject there is a wealth of information to be gleaned from theoretical discussions of, a bibliographical notes on, the methods selec

The first chapter is devoted to general l oratory practice, the theory of normal so tions, titrations, volumetric and gravime determinations, etc. The second and th chapters respectively deal with the anal of fertilizers and soils, and the fourth cha is devoted to the analysis of feeding st

Not the least valuable feature of the b is the attention paid to modern developme particularly in soil science, such as Neubau methods of physical soil analysis.

The volume comprises 348 pages of wh about 40 form an appendix dealing with analysis of dairy and other food product

F.T.W.

Nitrate Production Under Field Conditions in Soils of Central Alberta (1925-26).

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In a previous paper (2) we reported re-ılts for nitrate production under field con-itions in soils of Central Alberta for the ears 1923 and 1924. The data in the present aper are for some of the same plots for hich nitrate studies were continued during 925 and 1926.

It should be kept in mind that the climate any region very largely determines the mperature and moisture factors influencing e process of nitrification in soils. Further-ore, it has been responsible for the accumu-tion of relatively large amounts (more than)%) of organic matter in the soils reported the present studies. The soil tempera-res from May to September, inclusive, are ver too high to inhibit nitrification, and ldom sufficiently low to retard this process. owever, at times the lack of sufficient mois-re does materially affect the rate of nitri-ation. Data for soil moisture and tem-rature will not be included in the present per since such factors have previously been scussed (2) in some detail. For a more tailed discussion of such factors as com-sition of soil, crop sequence, cultivation methods, the reader is referred to previous papers (2 and 3).

The results for 1925 and 1926 confirm those already reported for 1923 and 1924. The data for nitrate nitrogen found in soils of plots variously cropped and cultivated for the years 1925 and 1926 are found in Tables 1 and 2, respectively. For purposes of comparison, some of these data are plotted in Figures 1 to 3.

There was a general tendency for nitrification to proceed as the season advanced until the maximum accumulation was reached some time after the middle, or near the end, of the season, as shown by the nitrate data for the fallow plots. (See Fig. 1, plot 10C, 1925, and plot 9B, 1926.). The temperature and moisture factors, including leaching, had some effect upon determining the exact date at which this maximum point was reached from season to season. This effect of season upon the time at which the high point in nitrate accumulation was reached may be better shown by the following summary for two fallow plots during the four years 1923 to 1926, inclusive.

NITRATE NITROGEN IN SOIL OF FALLOW PLOTS (parts per million).

		Highest Point During Season		
Year	Plot No.	p.p.m. in Surface Soil	Pounds per acre to depth of 40 inches	Date
1923	10C	63	267	Oct. 8
1924	9B	59	222	July 7
1925	10C	49	228	Oct. 19
1926	9B	76	437	Aug. 24

This summary, together with the curves own in Figures 1 and 2, gives a general a of the normal process of nitrification ing our seasons when this process was not turbed by the growing plants utilizing ni-tes and moisture.

However, when the plots were supporting various crops the maximum point in nitrate accumulation was usually reached during the early part of the season (just before the period of most vigorous plant growth) and thereafter this early season accumulation was followed by a rapid decrease in nitrates caused by the growth of crops. The decrease in nitrates continued from the beginning of most vigorous plant growth until just before

TABLE I.

Nitrate Nitrogen in Soil under various Crops in 1925 (parts per million).

Block Plot	Stratum	Crop sequence	May 4	June 12	July 15	Aug. 20	Sept. 21	Oct. 19	Average
1A	Surface	Oats following alfalfa	27.6	31.8	7.6	26.3	18.0	34.0	24.2
"	Subsurface		20.2	25.8	8.6	8.5	13.6	12.8	14.9
"	Subsoil		5.8	6.1	3.9	3.4	3.4	3.1	4.3
1B	Surface	Oats following timothy	16.8	13.1	6.0	12.8	9.7	16.4	12.5
"	Subsurface		10.1	14.2	5.4	9.2	4.0	6.8	8.3
"	Subsoil		4.1	4.7	2.6	3.0	2.2	5.1	3.6
1K	Surface	Oats following timothy	5.0	15.3	5.2	13.1	10.6	16.4	10.9
"	Subsurface		2.1	6.0	2.4	1.8	3.2	7.8	3.9
"	Subsoil		2.3	4.5	1.8	2.9	3.0	3.4	3.0
1L	Surface	Oats following alfalfa	6.5	13.2	2.7	13.2	15.1	12.3	10.5
"	Subsurface		3.8	3.7	1.3	2.8	2.8	4.9	3.2
"	Subsoil		3.3	2.0	2.2	2.1	1.8	3.7	2.5
8A	Surface	Clover following wheat	3.2	2.1	4.6	20.1	3.7	4.3	6.3
"	Subsurface		1.8	2.7	1.6	Trace	Trace	3.1	1.5
"	Subsoil		1.8	1.9	1.9	2.4	2.4	2.0	2.1
9B	Surface	Wheat following fallow	29.2	8.8	5.2	5.1	7.0	9.1	10.7
"	Subsurface		18.3	21.7	9.8	15.6	9.6	6.2	13.5
"	Subsoil		7.1	7.3	3.5	8.1	4.6	4.9	5.9
10C	Surface	Summerfallow following cereals	7.5	13.2	16.6	42.1	43.5	49.2	28.7
"	Subsurface		13.9	10.2	9.3	9.7	14.5	17.2	12.5
"	Subsoil		5.3	8.8	7.6	6.7	5.0	10.2	7.3
5B	Surface	Wheat following sweet clover	12.8	3.8	3.6	10.9	14.4	15.9	10.2
"	Subsurface		10.6	14.7	8.5	1.9	6.2	9.3	8.5
"	Subsoil		5.1	5.9	5.3	2.4	3.8	6.7	4.9

TABLE 2.

Nitrate Nitrogen in Soil under various Crops in 1926 (parts per million).

Block Plot	Stratum	Crop sequence	Apr. 23	May 25	June 23	July 24	Aug. 24	Sep. 24	Oct. 24	Average
1	Surface	Continuous prairie grass	1.8	1.9	1.4	1.5	2.6	3.3	2.3	2.1
1	Subsurface		1.0	1.3	Trace	Trace	Trace	Trace	Trace	0.3
1	Subsoil		Trace	Trace	Trace	None	None	None	None	---
1A	Surface	Summerfallow following oats	33.6	53.9	20.3	27.3	54.8	20.6	24.7	33.6
"	Subsurface		20.4	22.2	25.0	26.1	23.5	18.6	17.7	22.0
"	Subsoil		3.6	3.3	6.5	4.9	11.0	9.2	27.1	9.4
1B	Surface	Summerfallow following oats	24.4	25.6	15.0	30.1	42.8	25.8	25.0	26.9
"	Subsurface		10.1	9.2	14.8	22.0	16.5	25.4	22.5	17.2
"	Subsoil		2.6	2.8	1.9	3.6	4.4	12.6	10.4	5.5
1K	Surface	Summerfallow following oats	17.2	29.2	19.8	42.1	52.3	35.8	27.7	32.0
"	Subsurface		6.7	5.2	6.7	15.9	16.4	26.9	14.8	13.2
"	Subsoil		3.1	1.4	2.4	2.2	4.0	6.4	5.8	3.6
1L	Surface	Summerfallow following oats	15.6	15.3	32.8	47.2	31.5	67.1	24.5	33.4
"	Subsurface		5.2	4.2	29.2	16.2	40.0	17.7	24.4	19.6
"	Subsoil		2.3	1.1	12.7	3.2	3.9	6.6	9.9	5.7
8A	Surface	Clover following clover	3.3	4.4	2.9	2.5	5.1	15.0	16.1	7.0
"	Subsurface		1.8	1.8	1.8	Trace	2.2	3.3	5.5	2.2
"	Subsoil		1.6	1.3	Trace	None	Trace	2.2	Trace	0.7
9B	Surface	Fallow following wheat	17.2	26.3	12.2	56.0	76.3	26.1	24.6	34.1
"	Subsurface		16.2	16.7	19.8	14.1	25.1	24.1	11.1	18.1
"	Subsoil		12.1	6.4	11.6	9.1	30.6	35.4	15.5	17.2
10C	Surface	Rye following fallow	83.7	40.6	5.8	9.8	35.1	10.6	24.5	30.0
"	Subsurface		33.3	8.5	8.6	8.6	34.5	21.8	15.0	18.0
"	Subsoil		14.4	4.9	5.1	5.0	14.2	10.5	10.4	9.2
5B	Surface	Oats following wheat	17.8	31.1	7.8	4.0	22.9	17.6	7.7	15.6
"	Subsurface		19.2	11.6	18.0	4.7	22.6	16.1	4.5	13.8
"	Subsoil		4.0	4.5	5.4	4.3	16.4	5.8	7.6	6.9
2B	Surface	Corn following barley	19.6	42.8	13.5	14.5	55.9	16.5	15.7	25.5
"	Subsurface		7.1	4.5	12.5	14.8	21.2	16.8	30.0	15.[illegible]
"	Subsoil		10.7	6.0	6.3	9.9	23.5	11.1	30.5	14.0

harvest time when the low point was reached, unless, of course, conditions had been radically disturbed either by relatively long periods of excessive drought or rainfall. This point of low nitrates was dependent upon the nature of the crop occupying the plot. After harvest there was, in general, a tendency for the nitrates to increase somewhat until the end of the season.

Exceptions to the above statements were found either when a crop occupied a plot which had been summer fallowed during the previous season, or in the case of perennial crops. Under crops occupying plots which had been fallowed the previous year, the general tendency was for the nitrates to decrease with the advance of the season; whereas, when a permanent crop was grown as native prairie grass (plot 1) there was almost always a constant (relatively low) nitrate content during the entire season (see Figs. 1 and 2).

In a previous paper, it was pointed out that the crop grown, cultivation methods, etc., had a very marked effect upon the quantity of nitrates found in the soil at any time of sampling. This may further be emphasized by comparing plots 8A, 9B and 10C, Table 1, and again plots 1, 8A, 10C and 9B, Table 2, when it may be seen that the perennial crops constantly kept the nitrates relatively low and permitted of much less fluctuation than was found in the soil supporting an annual crop. Under continuous native prairie grass (plot 1, Table 2) the nitrate nitrogen never exceeded 3.3 p.p.m. during the season (see Fig. I); under clover (plot 8A, Tables 1 and 2) the only times the nitrate nitrogen exceeded 5 p.p.m. were in August, 1925, just after harvesting the crop, and again late in 1926 when the crop had been broken up (see Fig. 2, where the total nitrates under clover are compared with those under fallow). On the other hand, the nitrates in the fallow plots were always relatively abundant, on several occasions being in excess of 50 p.p.m. and in one instance as high as 83.7 p.p.m.

The general average columns in both Tables 1 and 2 are extremely interesting in that they show seasonal averages for nitrate

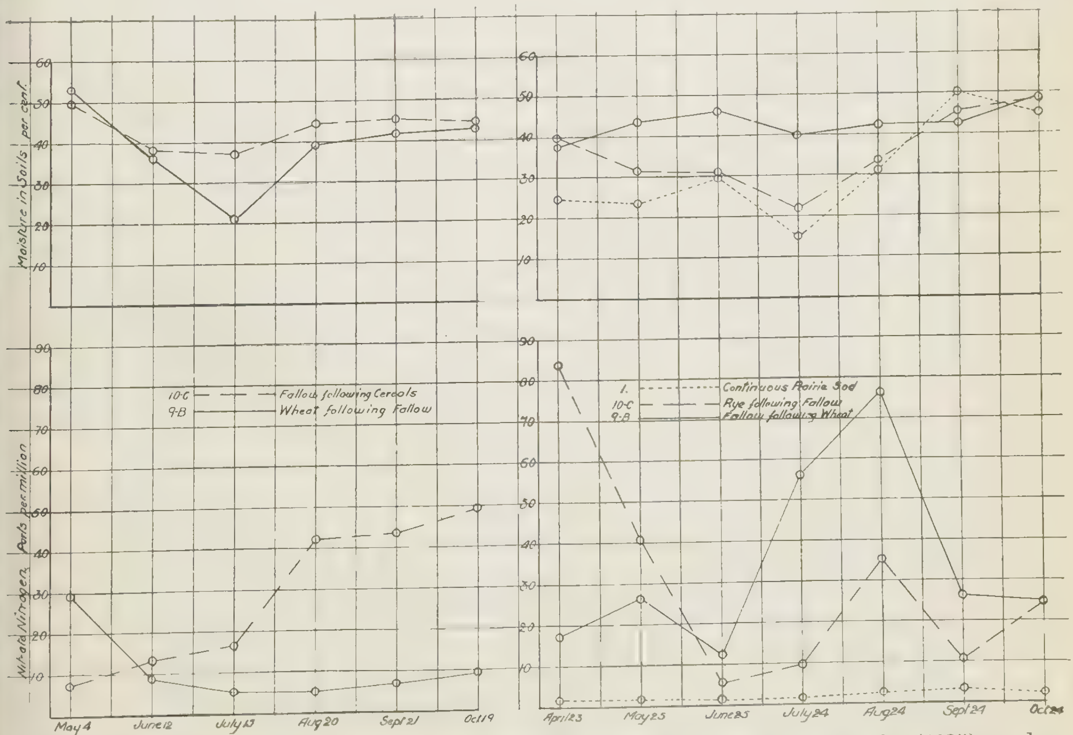

Fig. 1—Nitrate nitrogen and moisture in surface soil under various crops. Left (1925) under summer-fallow and wheat; right (1926) under continuous prairie grass, rye following fallow and fallow following wheat.

nitrogen in the surface soil to be relatively low for the perennial crops such as native prairie sod or Altaswede clover (about 2 and 7 p.p.m., respectively), and relatively high for the fallowed plots (from 27 to 34 p.p.m.). The columns further show that the season of 1926 was more favourable to nitrification than that of 1925. In fact, nitrification was more vigorous in 1926 than in any of the three preceding years, and it was during this year that the highest concentration (83.7 p.p.m.) for any date of sampling occurred.

In order to emphasize the effect of crop sequence and cultivation methods upon the production of nitrates by the same plot from year to year, the general seasonal averages of nitrate nitrogen in the surface soil (p.p.m.) for several of the plots for four consecutiv years have been assembled in Table 3. Thes data are taken in part from Tables 1 and 2 above, and in part from Tables 2 and 3, re ported in a previous paper(2).

From Table 3 it may be seen that whereve any perennial crop occupied the plot the sea sonal average of nitrate nitrogen was relative ly low, and, conversely, the nitrate nitroge was relatively high for the fallowed plots whereas, under annual crops the position o the nitrates was intermediate between th above two extremes. These relationships ar more clearly shown by referring to Fig. 3, i which the data from Table 3 are plotted. Th data in the column of averages for the fou years show that where two crops of alfalf

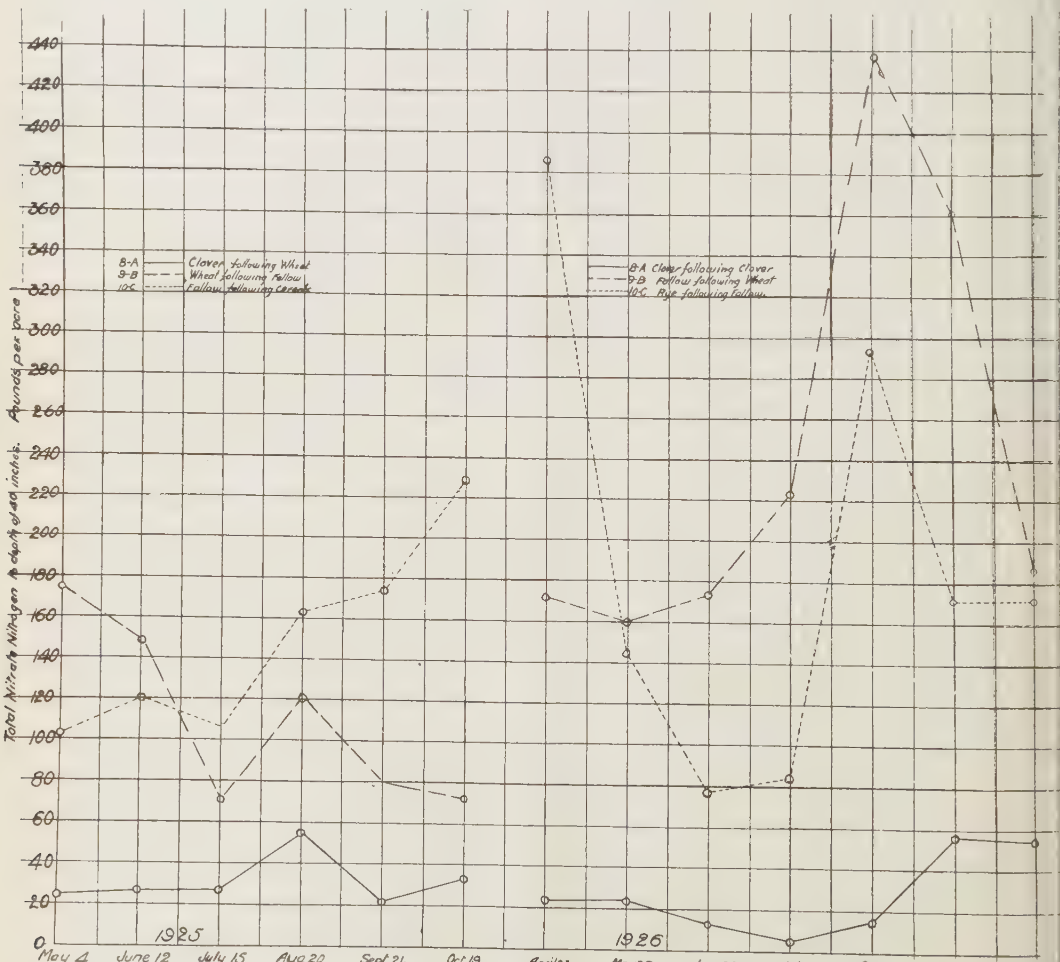

Fig. 2—Total nitrate nitrogen (pounds per acre) to the depth of 40 inches under clover, cereals and fallow for 1925 and 1926.

TABLE 3.
Seasonal Averages of Nitrate Nitrogen in Surface of 6 plots for 4 years (parts per million).

Plot	1923 Crop	1923 Nitrate Nitrogen	1924 Crop	1924 Nitrate Nitrogen	1925 Crop	1925 Nitrate Nitrogen	1926 Crop	1926 Nitrate Nitrogen	Average of 4 years Nitrate Nitrogen	Crops during 4 years
8A	Barley	17.1	Wheat and clover	10.8	Clover	10.3	Clover (plowed in fall)	7.0	10.3	2 cereals 2 clover
1B	Timothy	9.2	Timothy	10.3	Oats	12.5	Fallow	26.9	14.7	2 timothy 1 oats 1 fallow
5B	Sweet Clover	19.7	Sweet clover	18.2	Wheat	10.2	Oats	15.6	15.9	2 cereals 2 sweet clover
1A	Alfalfa	11.9	Alfalfa	15.0	Oats	24.2	Fallow	33.6	21.2	2 alfalfa 1 oats 1 fallow
9B	Cereals	Not sampled	Fallow	26.5	Wheat	10.7	Fallow	34.1	23.8	2 cereals 2 fallow
10C	Fallow	37.4	Wheat	24.4	Fallow	28.7	Rye	30.0	30.1	2 cereals 2 fallow

followed by oats and then by fallow occupied plot 1A the average nitrate nitrogen in the surface soil was 21.2 p. p. m. Where two crops of timothy (plot 1B) were substituted for the alfalfa, the average nitrate nitrogen was reduced to 14.7 p. p. m. Where two crops of cereals and two crops of clover (Altaswede) were grown (plot 8A), the average was 10.3 p.p.m., and where sweet clover was substituted for Altaswede the average nitrate nitrogen was 15.9 p.p.m. However, it should be remembered that the sweet clover in 1923 was sown rather late on fallowed soil, and again in 1924 it was closely pastured by sheep, which permitted of the production of greater quantities of nitrates than would be experienced had the sweet clover been nursed in a cereal and then later been permitted to utilize the nitrates by a vigorous crop growth similar to Altaswede on plot 8A.

The nitrates under both alfalfa and timothy (plots 1A and 1B) are, undoubtedly, greater than would have been the case under older stands of these crops, as they had occupied the plots only for a period of two years during the present studies and were broken late in 1924. That the nitrates are much lower under older stands of timothy is shown by Newton and Ficht (1), who report studies for timothy in another experiment at Edmonton showing that there is a distinct correlation between the nitrate content of the plots and the timothy yields. These investigators found only traces of nitrates in the soil of plots which had been supporting timothy for four or five years.

Where there had been two fallows and two cereals occupying plot 10C during the four year period, the average quantity of nitrate nitrogen (30.1 p.p.m.) present in the surface soil was about three times as great as under two crops of cereals and two crops of Altaswede clover (plot 8A); about twice as great as under two crops of timothy, one cereal and one fallow; and about one and one-half times as great as under two crops of alfalfa, one cereal and one fallow.

However, it is interesting to note that when the alfalfa and timothy were broken nitrification proceeded more vigorously and at an earlier date under alfalfa than under timothy. This increased nitrification under the legumes, likewise, persisted throughout the seasons of 1925 and 1926. (see Fig. 3).

The above summarized statements bring out the differences in nitrate production for six of the plots during four years when the plots were supporting different crops and being subjected to different cultivation practices. On the other hand, a similar summary may be prepared from the data for the past four years showing the relative abundance of nitrate nitrogen in the soil under different crops when they did not necessarily occur in the same sequence. Such a summary is found in Table 4. These data show the effect of the various crops, together with fallow practice, upon the average seasonal content of nitrate nitrogen in the soil producing such crops, and are arranged in descending order.

From this table it may be seen that the nitrates in the surface soil under fallow were approximately one and one-half times as great as under intertilled crops, two times as great as under the annual non-tilled crops, more than four times as great as under clover, and more than fourteen times as great as under native prairie grass. Again, the total nitrat nitrogen per acre to the depth of forty inche under fallow was approximately two times a great as under the non-tilled annuals, si times as great as under clover, and thirt three times as great as under the nativ prairie grass. The significance of some c these differences may further be seen by r ferring to Figures 1 and 2.

The above data and discussions apply t the black soils of Alberta and would be r presentative of the most vigorous degrees c nitrification occurring in the province unde field conditions. The process of nitrificatio should be of this same order for the greate part of the black soils (about seven millio acres). However, for the plains (brow soils) part of Alberta, and the wooded (po sol-like) soils, the nitrification would, u doubtedly, be less than for the black soil The lack of moisture would be the chief fa tor limiting nitrification in the plain soil whereas the composition and reaction of soi

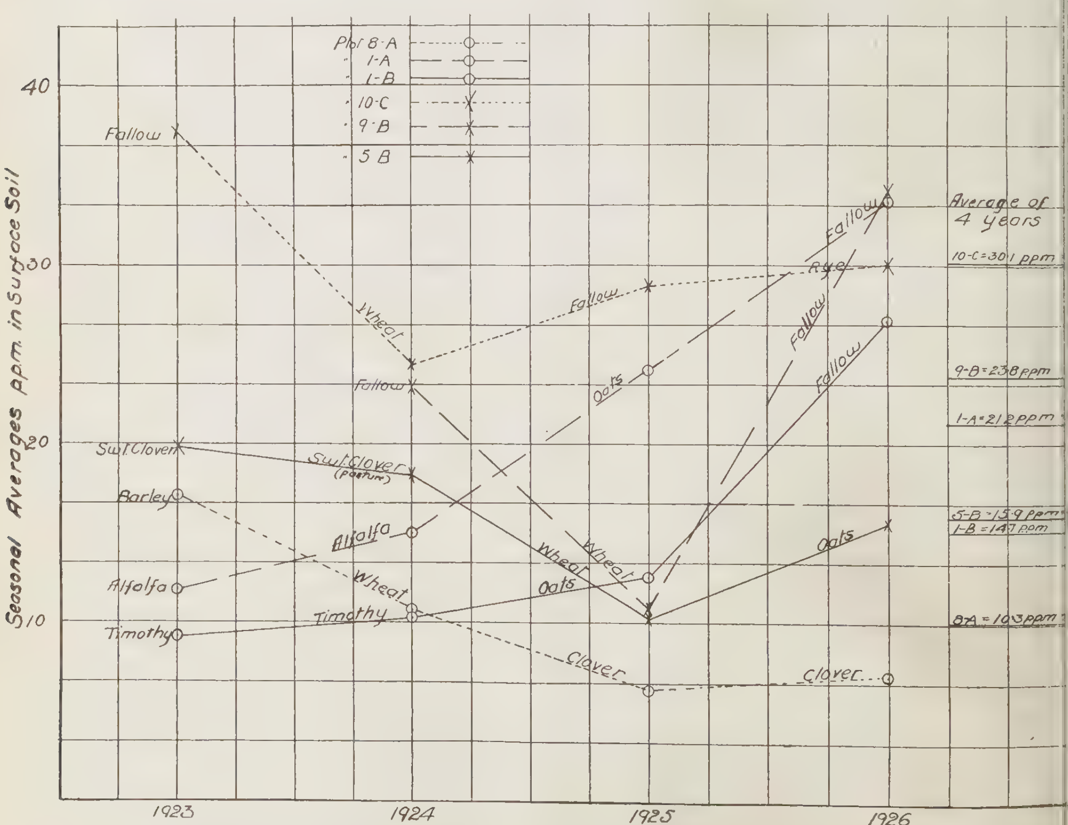

Fig. 3—Seasonal averages of nitrate nitrogen (p.p.m.) in surface soil for six plots, showing effect of crop sequence upon nitrate production (1923 to 1926).

TABLE 4.

Comparison of Averages of Nitrate Nitrogen in Soil Under Various Crops (parts per million and pounds per acre).

Number and kind of crop	6 fallows	3 corn	2 potatoes	3 oats	4 wheat	2 alfalfa	2 timothy	2 Altaswede clover	1 prairie grass
Nitrate nitrogen in surface soil, p. p. m.	31.2	20.3	19.5	17.4	14.0	13.5	9.8	6.7	2.1
Nitrate nitrogen, pounds per acre to depth of 40 inches	184.1	x	x	99.1	106.7	x	x	29.3	5.5

x Not sampled below surface soil.

rather than the moisture, would be the limiting factors for the wooded soils. Some nitrification studies, much less extensive than for the black soils, have been conducted for both the plains soils and the wooded soils, and these studies substantiate the above general statements, namely: that the process of nitrification is of the same nature, but of a lesser degree, for the plains and the wooded soils as for the black soils.

During the summer of 1926, Mr. E. G. Bayfield, Agronomist at the Claresholm School of Agriculture, supplied the authors with soil samples from four different plots collected at four different dates, and we wish to express our appreciaion of his co-operation in this connection. Nitrate nitrogen was determined in all these samples and the data are recorded in Table 5. The degree of nitrification shown in Table 5 may be considered as representative of the very dark brown soils occurring between the plain soils and the black soils.

From Table 5 it may be seen that the same relationship exists between the nitrates in the plots under perennials, annual crops and the fallow at Claresholm as was pointed out for the Edmonton plots. However, the rate of nitrification at Claresholm was only about one half that found at Edmonton. On the other hand, it is apparent that nitrification in in the Claresholm soils was sufficiently vigorous to meet the demands of the growing crops. It is quite evident from the column of averages that nitrification proceeds more vigorously under alfalfa (plot 265) than under brome (plot 264), even though these two crops had occupied the plots since 1919.

Summary

Nitrification studies in soils under field conditions have been conducted at Edmonton during the four years 1923 to 1926. Plots were so selected that it was possible to compare the effects of different crops and crop sequences, together with non-tilled, intertilled and fallow cultivation practices, upon the process of nitrification, as measured by nitrate accumulations, throughout the summer season. The results of the first two seasons were reported in a previous paper (2), and those for the years 1925 and 1926, together with general averages for the four years, are summarized in the present paper.

Daily soil temperatures were recorded for each of the four seasons, and moisture deter-

TABLE 5.
Nitrate Nitrogen in Soil under Various Crops at Claresholm in 1926 (parts per million).

Plot	Depth	Crop sequence	April 27	May 25	July 20	Sept. 18	Average
261	Surface	Continuous wheat since	13.1	16.6	6.4	5.0	10.3
"	Subsurface	1919	4.6	4.6	3.2	3.3	3.9
"	Subsoil		4.9	4.6	3.3	2.3	3.8
264	Surface	Continuous brome since	1.6	3.1	4.7	3.0	3.1
"	Subsurface	1919	1.9	2.6	3.9	2.1	2.6
"	Subsoil		1.3	3.0	3.8	2.3	2.6
265	Surface	Continuous alfalfa since	1.6	5.9	6.9	5.9	5.1
"	Subsurface	1919	2. 7	5.1	4.6	5.2	4.4
"	Subsoil		1.6	2.0	4.4	7.5	3.9
266	Surface	Rotation since 1919: al-	14.2	8.7	32.0	7.4	15.6
"	Subsurface	falfa; western rye grass,	12.1	6.2	8.0	5.7	8.0
"	Subsoil	4 years; wheat; oats; summerfallow. Summerfallow in 1926.	7.3	7.4	9.3	11.6	8.9

minations were made for all of the soil samples collected.

The soil temperatures from May to September, inclusive, were never found to be too high to inhibit nitrification, and seldom sufficiently low to retard this process (see (2)). However, at times the lack of moisture did materially affect the rate of nitrification.

The soils of Alberta were, in general, well supplied with the nitrifying organisms, as indicated by experiments not reported in this paper.

The soils of the plots reported in this paper contain an abundance of mineral plant foods and a comparatively large amount of organic matter (at least 10% of the surface soil is organic matter).

There was a distinct relationship between the moisture and nitrate contents of the soil, especially during the early part of the season, until the rapid rate of plant growth disturbed this relationship. However, in general, the nitrate production showed a slight lag behind the moisture and temperature fluctuations. The soil temperatures were largely influenced by the rainfall and air temperatures; in general, the soil temperatures were inversely proportional to the soil moisture.

The production of nitrates in field soils was influenced by the crop growing, the crop sequence, the method of cultivation, together with moisture and temperature factors. The perrenial crops kept the nitrates at a lower level than did the annuals. The non-tilled annuals, such as wheat, barley and oats, kept the nitrates slightly lower than the intertilled crops, such as corn and potatoes. The summerfallow showed much greater accumulations of nitrates than were found under corn or potatoes.

From the averages for four years it was found that the nitrates in the surface soil (31.2 p.p.m.) under fallow were approximately one and one-half times as great as under intertilled crops, two times as great as under annual non-tilled crops, more than four times as great as under Altaswede clover, and more than fourteen times as great as under native prairie grass (2.1 p.p.m.). Again, the total average annual nitrate nitrogen per acre under fallow (184 pounds) was approximately two times as great as under non-tilled annuals, six times as great as under Altaswede clover, and thirty-three times as great as under the native prairie grass (5. pounds).

Nitrification in the black soils of Alberta was found to be relatively very vigorous; in fact, there was no indication of nitrate deficiency under any of the crops studied except, perhaps, in the case of perrenials which have occupied the land for several years. Under old stands of perrenial grasses the lack of sufficient nitrates undoubtedly limits the yields (see (1)).

Nitrification proceeded more vigorously following alfalfa than following timothy, and the superiority in this respect persisted for at least two years after these crops had been broken.

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3. Wyatt, F. A., 1925. Factors affecting the productivity of Western Canadian soils. Scientific Agr. V. 6, No. 3, p. 69-88.

A Nematode Discovered on Wheat in Saskatchewan.*

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During the summer of 1926, in the course of our field survey for root-rotting organisms on cereal crops, we discovered a nematode on the roots of wheat plants. This nematode was found in eight widely separated fields in the Humboldt district, a region lying about one hundred miles east by north-east of Saskatoon. This region is a rolling, partially wooded country and most of its soil is a black sandy loam. The majority of fields in which this eelworm was found have been under cultivation for only a few years and have produced wheat every year since they were broken. We looked for the nematode in other districts where root rots are prevalent, but we did not succeed in finding it.

The affected plants were usually found in ragged-looking weedy patches, and they were more or less stunted. In many cases they bore a heavy infestation of nematodes on their primary roots and a lighter infestation on their secondary roots. It is known that certain nematodes attack a wide range of host plants, including pigweed. Therefore the roots of the latter, growing among attacked wheat plants, were examined for the presence of eelworms, but none were found on them.

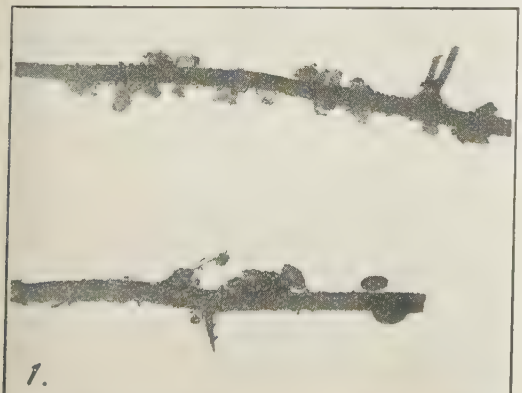

Fig. 1 A photomicrograph showing dead female nematodes attached to wheat roots. An average sized female at this stage measures about 480 x 280 microns.

Collections of these nematodes on the roots of wheat were made from June 10th to August 13th. They were first discovered when the wheat was in the seedling stage and, at that time, mature eggs were not present in the females. Later in the season the gravid females died, but remained attached by their heads to the wheat roots, forming silvery-white sacs which were easily recognizable with the naked eye. Beneath the outer silvery-white coat is a tough brown coat which forms a protective covering for the eggs until conditions are favorable for them to hatch. Each of these dead females contained scores of oval eggs, with the young larvae coiled up inside the eggs. Figure 1 shows portions of two wheat roots with a number of dead females attached to them; figure 2 shows a dead female broken open in order to expose the eggs. The point by which the female was attached to the root and one free larva can also be seen in this figure.

*Contribution from the Division of Botany, Experimental Farms Branch, Department of Agriculture, Ottawa, Canada.

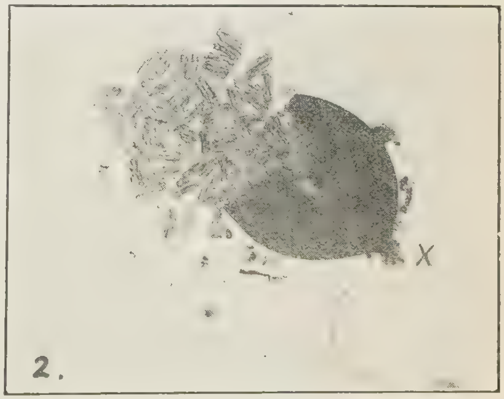

Fig. 2—A dead female crushed open in order to show the eggs. The eggs measure about 110 x 47 microns. One larvae is shown below. The point of attachment is marked X.

(Photomicrographs by G. A. Scott and R. C. Russell).

Specimens of this organism were sent to the Bureau of Plant Industry, U.S.D.A., Washington, D.C., for identification. Two of the American nematologists, Dr. Steiner of Washington and Mr. Thorne of Salt Lake City, Utah, have gone into the question of its classification very carefully and have generously supplied us with much valuable information concerning it and similar forms. According to Mr. Thorne, this nematode very closely resembles *Heterodera schachtii* Schmidt, an organism which causes considerable damage to sugar-beets in Germany and the United States. It shows certain differences, however, and a further study of these may possibly prove the organism to be a new species. Mr. Thorne, who has been working on the sugar-beet nematode for a number of years, intends to investigate the matter further and will probably publish the results of his findings at a later date.

According to Dr. Steiner, *H. schachtii* has ben reported on wheat in Germany on several occasions, but, as far as we know, it has not previously been reported on wheat in America. From our limited field observations it is difficult to offer an opinion as to whether or not the form which we have is likely to prove a serious wheat parasite. The presence of various root-rotting fungi in the same fields in which we found the nematode made impossible an accurate estimate of the damage done by the latter. It may be that the two go hand in hand, the nematode facilitating the entry of the fungi into the tissues of the roots. Judging from the number of cysts found upon the roots of certain plants, however, it appeared that the nematodes alone would weaken the plants considerably by feeding on the plant juices and by burrowing into the root tissues.

These nematodes in Saskatchewan are subjected to relatively great changes in temperature. The Physics Department of the University of Saskatchewan has unpublished soil temperature records (1) for one year, taken from the autumn of 1922 to the autumn of 1923. In these the average daily temperatures show an extreme variation of from –0.9° to 66.6°F. at a depth of one foot, and from 19.4° to 51.9° F. at two feet. Other data, compiled at the Dominion Entomological Laboratory at Saskatoon during the past three years, show an extreme variation from –2.5° to 90.5°F., between the minimum and maximum temperatures recorded at a depth of three inches in sod land. Dr. A. E. Cameron (2) states, "On the prairies the temperature of the first six inches of soil falls to 10° Fahr., below zero during the winter. At three inches, temperatures of –20° are recorded. Frost penetrates the soil to a depth of at least six feet."

Under greenhouse conditions we have attempted to secure infection of wheat and sugar-beet seedlings. Nematode infested soil and wheat roots from the field were mixed with the soil in which the seedlings were grown. So far only negative results have been obtained from these experiments, possibly on account of unsuitable conditions of temperature and moisture. We hope to learn more about the distribution and importance of this nematode next summer.

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1. Dr. E. L. Harrington, of the Physics Department, intends to publish these records during the present year.

2. A. E. Cameron. Soil Insects. Science Progress 20:77:101.

A Note on Raspberry Breeding.

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It is now generally conceded that the purple raspberry is of hybrid origin and not a native species as was supposed by Peck, formerly New York State Botanist, who named it *Rubus neglectus.* Work carried on at the New York State Experiment Station (1) definitely proved this hybrid origin.

Experiments in crossing the black and red raspberries carried out at the New York State Experiment Station, Geneva, N.Y., at the U.S. Horticultural Field Station, Bell, Md., and at the Horticultural Experiment Station, Vineland, Ontario, show that purple raspberries result from crossing the black and red raspberries. However one peculiarity in connection with these crosses, apparently not reported by the New York State Experiment Station (1) but reported by the Horticultural Experiment Station, and by the U.S. Horticultural Field Station, Bell, Md. (3) was the apparent necessity of making the cross a certain way to produce the characteristic hybrid purple.

At the Horticultural Experiment Station crosses were made between *Rubus occidentalis* (wild black) and *Rubus strigosus* (wild red), also between Gregg (black) and Cuthbert (red).

One hundred and forty plants of *Rubus occidentalis* x *Rubus strigosus* were fruited. The growth and foliage indicated a compromise in that the tips of the new growth were the same color as the wild red canes and darker than the wild black and were more upright and less thorny than the wild black. The fruit was of the purple cane type and inferior in quality, size and appearance.

From a cross of Gregg x Cuthbert 150 plants were fruited. Of this number 117 bore purple cane type of fruit with intermediate type of canes and foliage, 28 were to all appearances black caps and 7 were red raspberries.

The reciprocals of the above crosses gave quite different results. Of the cross *R. strigosus* x *R. occidentalis*, 130 plants were fruited. The foliage was the same as the wild red raspberry. The fruits were all *red* and slightly drier and firmer than the wild red. The canes were thornier than the wild red but were all of the red raspberry type. The Cuthbert Gregg cross gave all *red* raspberries. In 1922 open pollinated seed was saved from these red plants. Fifty seedlings from this seed were fruited in 1926 and all of them were red fruited.

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A Prince Edward Island Weed Survey.*

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Commencing at Port Borden, P.E.I., on Saturday afternoon, July 24, 1926, a two weeks' weed survey of the Island was carried out.

For several years past a month or two each summer has been spent in field work of this nature. Heretofore each trip has been made to compass as wide a territory as possible,—at that, however, a mere patch on the vastness of Canada's extent. This time the aim was to take a well-defined area, not too large, and work it more intensively. The possibility in the case of Prince Edward Island, of making an entire province the unit of area, was considered to have much in its favor; and plans were accordingly made to cover it as completely and uniformly as might be consistent with economical use of time.

In order that each county, parish, and as far as possible, each lot in the province, might be reached, the entire railway mileage (about 275 miles) was to be traversed. This was accomplished pretty fully; and in addition, more than 100 miles were travelled by automobile in reaching places away from rail. By these means notes were obtained more or less extensively in 55 of the 74 lots and towns, no lot left unvisited being, at its nearer borders, more than a few miles distant from a point of survey. Admittedly it was little more than a reconnaissance, and that at only one stage of the season's vegetation, but even so no less than 240 weeds, poisonous plants, and introduced plants escaped and fending for themselves, were recorded in from one to over 50 lots each.

The plan of survey was to spend as much time as train connections would allow at suitable stop-over points, and continue observations *en route;* driving trips being made to work out in much the same way. As the base of operations, Charlottetown and vicinity received the greatest amount of attention, parts of several days being spent in the field there. From one or two hours to perhaps half a day was the usual time available at stop-overs. On such occasions lists of 100 to 125 or more species, neglecting non-economic native plants, would be made. The lists secured *en route* were necessarily less complete, but were considered an essential part of the survey, as indicating by frequency reported, the prevalence of such weeds as could be thus recognized. These lists were regularly repeated at suitable intervals; in the case of railway travel usually for each station passed. The time available during stops, especially on the slower way-trains—which were utilized whenever possible,—was sufficient, along with observations from the moving train, to furnish lists of 20 to 50 species. In the majority of lots these, usually several times repeated, would be the only records obtained; and the stop-over points distributed through the various parishes had to serve for the detection of most of the less conspicuous and rarer weeds of each region. At these points also, specimens were secured for pressing, of doubtfully identified species, and others of special interest, or whose occurrence might be questioned later. As far as possible observations on the physical character of the country passed through, and its predominant vegetation, including weeds, were jotted down; but in a province of such moderate contrasts these were of course of rather less than usual consequence. Obviously too, repetition of lists at such frequent intervals, left little time over; and, incidentally, is a method of survey sufficiently exacting on mental and physical endurance to call for some fitness and acquired skill.

Reviewing at this date, with note-books at hand, the busy fortnight of work just outlined, it is possible to recall quite vividly the more salient features of each stage of the journey,—a spying out of the country which was replete with interest from first to last. Only the demands of brevity can condone the palpable injustice, in what is to follow, of making to appear one long procession of

*Contribution from the Division of Botany, Experimental Farms Branch, Department of Agriculture, Ottawa.

weeds, what was just as truly, an almost uninterrupted panorama of delightful pastoral scenery and substantial agriculture unequalled in any other province, taken as a whole.

It must have been an impulse of whimsicality, although faithful enough to fact, that led to recording at the top of the list of Prince Edward Island weeds, a plant that is such in name only, and occurs in its waters only, namely seaweed. If a weed is merely a plant out of place, then surely seaweed can always be counted on to prove an alibi!

Whimsicalities aside, the weeds, poisonous plants, and introduced plants growing without cultivation, (including of course some plants highly useful or perfectly harmless in their proper places), which were noted at Port Borden during the brief period of transfer from ferry to train and from there to the next point of travel, were those listed below. Poisonous and introduced weeds are so designated by letters (P. and I.) preceding the name. After each name is given a figure indicating the number of lots and towns in which it was observed during the entire survey; this being an index of its prevalence, though not necessarily of its actual importance, which depends as well on other considerations. Yarrow for instance, though not particularly noxious, happens to be the only weed recorded in every place.

Weeds observed at Port Borden, P.E.I.—

I.	White Clover—*Trifolium repens* L.	52
I.	Ox-eye Daisy—*Chrysanthemum Leucanthemum* L.	52
I.	Red Clover—*Trifolium pratense* L.	38
I.	Alsike Clover—*Trifolium hybridum* L.	33
I. P.	Tall Buttercup—*Ranunculus acris* L.	52
I.	Couch grass—*Agropyron repens* (L.) Beauv.	42
I.	Sheep Sorrel—*Rumex Acetosella* L.	41
	Common Yarrow — *Achillea millefolium* L.	55
I.	Toadflax—*Linaria vulgaris Hill.*	17
	Common Plantain—*Plantago major* L.	37
I.	Live-forever — *Sedum purpureum* Tausch.	
I.	Common Dandelion—*Taraxacum officinale* Weber	39
P.	Common Horsetail—*Equisetum arvense* L.	28
I.	Pineappleweed—*Matricaria suaveolens* (Pursh) Buchenau	39
I.	Blue Bur—*Lappula echinata* Gilib.	2
I.	Common Mouse-ear Chickweed—*Cerastium vulgatum* L.	35
I.	Shepherd's Purse—*Capsella Bursa-pastoris* (L.) Medic.	11
I.	Fall Dandelion—*Leontodon autumnalis* L.	53
I.	Apple—*Pyrus Malus* L.	21
	Knotweed—*Polygonum aviculare* L.	29
I.	Viscous Groundsel—*Senecio viscosus* L.	11
I.	Smoothish Hawkweed—*Hieracium floribundum* Wimm. & Grab.	25
I.	Canada Thistle—*Cirsium arvense* (L.) Scop.	52
	Northern Evening Primrose—*Oenothera muricata* L.	34
	Great Willow-herb—*Epilobium angustifolium* L.	49
	Tufted Vetch—*Vicia Cracca* L.	46
I.	Hop Clover—*Trifolium agrarium* L.	31
I.	Timothy—*Phleum pratense* L.	42
	Pearly Everlasting—*Anaphalis margaritacea* (L.) B. & H.	54
	Daisy Fleabane—*Erigeron ramosus* (Walt.) BSP.	46
I.	Bladder Campion—*Silene latifolia* (Mill.) Britten & Rendle	6
I.	Meadow Pea—*Lathyrus pratensis* L.	1
P.	Sheep Laurel—*Kalmia angustifolia* L.	44
P.	Bracken—*Pteris aquilina* L.	52

This list of 34 species from wharf, street, railway yard and right of way, and adjoining wild and farming land is a fair sample of what could be seen and recorded at almost any point on the Island where train service was not too speedy. The figures given show widespread occurrence for the great majority.

At Carleton, the next stop, with somewhat less time, a second list of 23 names repeated 18 of those already observed, failed to repeat 16, and added the five listed herewith:

	Self-heal—*Prunella vulgaris* L.	30
P.	Red Baneberry—*Actaea rubra* (Ait.) Willd.	4
	Hay-scented Fern—*Dicksonia punctilobula* (Michx.) Gray	37
	Sensitive Fern—*Onoclea sensibilis* L.	35
I.	Orange Hawkweed—*Hieracium aurantiacum* L.	11

The differences between these two lists are not to be taken too seriously. The plants occurring at one station may all have been observable at the next, but occurrence in both lists is at least indicative of obtrusiveness, or perhaps mere size or showiness.

Albany, the next station, contributed:

I. Curled Dock—*Rumex crispus* L. 42
I. Lamb's Quarters—*Chenopodium album* L. 42
I. Hemp Nettle—*Galeopsis Tetrahit* L. 27
Cone Flower—*Rudbeckia hirta* L. 32
I. P. Tansy Ragwort—*Senecio Jacobaea* L. 29

At Kinkora was first seen:

I. Bull Thistle—*Cirsium lanceolatum* (L.) Hill. 26

At Emerald Junction, with a little more time again, 34 species were recorded, eight of them as follows, for the first time:

I. Low Hop Clover—*Trifolium procumbens* L. 38
I. Tumbling Mustard—*Sisymbrium altissimum* L. 7
Low Cudweed—*Gnaphalium uliginosum* L. 40
I. Grass-leaved Stitchwort—*Stellaria graminea* L. 31
I. Lady's Thumb—*Polygonum Persicaria* L. 24
I. Perennial Sow Thistle—*Sonchus arvensis* L. 35
Halberd-leaved Orache—*Atriplex hastata* L. 16
I. Tansy—*Tanacetum vulgare* L. 15

From Emerald Junction to Charlottetown, in view of the lateness of the time and the certainty that the line would have to be travelled again, no notes were taken.

The several forays in and around Charlottetown, commencing Monday, July 26, yielded 122 species; not an unduly large number for the time employed. All but nine of the species already enumerated were found present, and the rest are given below—in order alphabetically by scientific names.

I. Sneezewort—*Achillea Ptarmica* L. 5
Rough Hair Grass—*Agrostis hyemalis* (Walt.) BSP. 10
I. Creeping Bent Grass—*Agrostis stolonifera* L. 25
I. Brown Top—*Agrostis tenuis* Vasey 49
I. Redroot Pigweed—*Amaranthus retroflexus* L. 4
Common Ragweed—*Ambrosia artemisiifolia* L. 3
Giant Ragweed—*Ambrosia trifida* L. 1
Everlasting—*Antennaria* (*petalloidea* Fernald, and others) 23
I. Sweet Vernal Grass—*Anthoxanthum odoratum* L. 4
I. Common Burdock—*Arctium minus* Bernh. 32
Biennial Wormwood—*Artemisia biennis* Willd. 4
I. Barberry—*Berberis vulgaris* L. 2
Common Beggar-ticks—*Bidens frondosa* L. 12
I. P. Wild Mustard—*Brassica arvensis* (L.) Ktze. 12
I. Bird Rape—*Brassica campestris* L. 3
I. Indian Mustard—*Brassica juncea* (L.) Cosson 3
Crawford's Sedge—*Carex Crawfordii* Fernald (and other species) 8
I. Feverfew—*Chrysanthemum Parthenium* (L.) Bernh. 2
Hedge Bindweed—*Convolvulus sepium* L. 18
I. English Hawthorn—*Crataegus Oxyacantha* L. 10
I. Orchard Grass—*Dactylis glomerata* L. 7
Wild Oat Grass—*Danthonia spicata* (L.) Beauv. 48
I. Barnyard Grass — *Echinochloa Crus-galli* (L.) Beauv. 8
Wild Cucumber — *Echinocystis lobata* (Michx.) T. & G. 3
P. Wood Horsetail—*Equisetum sylvaticum* L. 18
P. Wormseed Mustard *Erysimum cheiranthoides* L. 9
Sheep's Fescue—*Festuca ovina* L. 1
Red Fescue—*Festuca rubra* L. 2
Marsh Bedstraw—*Galium palustre* L. 10
Sea Milkwort—*Glaux maritima* L. 4
I. Jerusalem Artichoke — *Helianthus tuberosus* L. 3
I. Mouse-ear Hawkweed— *Hieracium Pilosella* L. 34
I. Wild Barley—*Hordeum jubatum* L. 8
I. Common St. John's Wort—*Hypericum perforatum* L. 17
I. Small-flowered Balsam—*Impatiens parviflora* DC. 1
Toad Rush—*Juncus bufonius* L. 10
Common Rush—*Juncus effusus* L. 2

	Slender Rush—*Juncus tenuis* Willd.	7
	Wild Lettuce—*Lactuca canadensis* L.	11
	Common Wood Rush — *Luzula campestris* (L.) DC. var. *multiflora* (Ehrh.) Celak.	19
	Bugleweed — *Lycopus* (*americanus* Muhl., and others)	10
I.	Scentless Chamomile—*Matricaria inodora* L.	27
I.	Black Medick — *Medicago lupulina* L.	11
I.	White Sweet Clover — *Melilotus alba* Desr.	8
I.	Ground Ivy — *Nepeta hederacea* (L.) Trevisan	6
	Small Sundrops—*Oenothera pumila* L.	4
	Wood Sorrel—*Oxalis* (*stricta* L.?)	9
I.	Ribgrass—*Plantago lanceolata* L.	3
I.	Low Spear Grass—*Poa annua* L.	21
I.	Canadian Blue Grass — *Poa compressa* L.	27
	Fowl Meadow Grass—*Poa triflora* Gilib.	1
I.	Wild Buckwheat—*Polygonum Convolvulus* L.	25
	Erect Knotweed—*Polygonum erectum* L.	1
P.	Smartweed — *Polygonum Hydropiper* L.	21
	Silverweed—*Potentilla Anserina* L.	12
	Upright Cinquefoil — *Potentilla monspeliensis* L.	21
P.	Choke Cherry—*Prunus virginiana* L.	4
I.	Horse Radish — *Radicula Armoracia* (L.) Robinson	3
I. P.	Creeping Buttercup — *Ranunculus repens* L.	23
I.	Wild Radish—*Raphanus Raphanistrum* L.	18
	Staghorn Sumach—*Rhus typhina* L.	10
I.	Black Locust — *Robinia Pseudo-Acacia* L.	4
I.	Golden Glow—*Rudbeckia laciniata* L.	12
I.	Bitter Dock—*Rumex obtusifolius* L.	13
	Painted Glass wort — *Salicornia europaea* L.	2
I.	Purple Willow—*Salix purpurea* L.	1
I.	Bouncing Bet—*Saponaria officinalis* L.	6
I.	Common Groundsel—*Senecio vulgaris* L.	22
I.	Hedge Mustard—*Sisymbrium officinale* (L.) Scop.	10
	Blue-eyed Grass—*Sisyrinchium angustifolium* Mill.	3
	Canada Golden-rod—*Solidago canadensis* L.	34
	Narrow-leaved Golden-rod — *Solidago graminifolia* (L.) Salish.	43
I.	Smooth Perennial Sow Thistle — *Sonchus arvensis* L. (Smooth variety)	1
I.	Common Annual Sow Thistle — *Sonchus oleraceus* L.	4
I.	Common Spurrey—*Spergula arvensis* L.	27
	American Meadow-sweet—*Spiraea latifolia* Borkh.	25
I.	Common Chickweed — *Stellaria media* (L.) Cyrill.	22
P.	Arrow Grass—*Triglochin maritima* L.	2
I.	Bush Vetch—*Vicia sepium* L.	1

These weeds of Charlottetown are representative of almost every type to be found anywhere in the province. Street, roadside, railway property, neglected lot, garden, lawn, arable field, pasture, woodland, swamp and brackish marsh and shore all contributed their quota. The weeds still to be reported from other places could occur, and many of them, no doubt would be found here in the course of a more exhaustive survey, such as might be carried on by someone locally resident.

The weeds added by the next, an afternoon automobile expedition eastward through Queens and Kings counties, are as follows:

I.	Caraway—*Carum Carvi* L.	18
I.	Musk Mallow—*Malva moschata* L.	6
I.	Common Comfrey — *Symphytum officinale* L.	2
I.	Smaller Common Vetch—*Vicia angustifolia* (L.) Reichard	16
I.	Tournefort's Speedwell—*Veronica Tournefortii* C. C. Gmel. (persica)	1
	Pennsylvania Persicaria — *Polygonum pennsylvanicum* L.	3
	Field Scorpion-grass—*Myosotis arvensis* (L.) Hill.	
I.	Creeping Bellflower — *Campanula rapunculoides* L.	7
I.	Sweet-brier—*Rosa rubiginosa* L.	6
P.	Water Hemlock—*Cicuta maculata* L.	9

I.	Red Top—*Agrostis alba* L. (*stolonifera* L. var. *major* (Gaud.) Farwell	5
I.	Mullein—*Verbascum Thapsus* L.	8
	Sand Spurrey—*Spergularia rubra* (L.) Presl.	12
I.	White Poplar—*Populus alba* L.	8
P.	Ground Hemlock—*Taxus canadensis* Marsh.	1
P.	Blue Flag—*Iris versicolor* L.	22
	Sweet Fern—*Myrica asplenifolia* L.	15
P.	Slender Nettle—*Urtica gracilis* Ait.	4
	Joe-Pye Weed — *Eupatorium purpureum* L.	31
	Common Speedwell—*Veronica officinalis* L.	4
I.	Wild Parsnip—*Pastinaca sativa* L.	7
I.	Velvet Bent Grass—*Agrostis canina* L.	1
	Rattlebox — *Rhinanthus Crista-galli* L.	5
P.	Elderberry—*Sambucus canadensis* L.	12

A second route through the eastern part of the island to Georgetown, taking the greater part of two days for leisurely touring, gave extensive weed lists containing the following for the first time:

P.	Water Parsnip — *Sium cicutaefolium* Schrank.	14
	Wild Rose—*Rosa* (native species)	32
I.	Manitoba Maple—*Acer Negundo* L.	6
	Canada Fleabane—*Erigeron canadensis* L.	22
	Tall Blue Lettuce—*Lactuca spicata* (Lam.) Hitchc.	11
	Eyebright— *Euphrasia* (*americana* Wettst. and others)	12
	Agrimony — *Agrimonia striata* Michx. (and *gryposepala* Wallr.)	4
I.	Lombardy Poplar—*Populus nigra* L. var. *italica* Du Roi	5
	Hop—*Humulus Lupulus* L.	9
	Yellow Avens—*Geum strictum* Ait.	5
P.	Indian Tobacco—*Lobelia inflata* L.	3
I.	Night-flowering Catchfly — *Silene noctiflora* L.	3
I.	European Field Pansy—*Viola arvensis* Murr.	1
I.	Lilac—*Syringa vulgaris* L.	12
I.	Motherwort—*Leonurus Cardiaca* L.	2
I.	Field Hawkweed—*Hieracium pratense* Tausch.	4
	Kentucky Blue Grass—*Poa pratensis* L.	11
I.	Stinking Mayweed—*Anthemis Cotula* L.	1
I.	Buckwheat — *Fagopyrum esculentum* Moench.	11
	Arrow-leaved Tear-thumb — *Polygonum sagittatum* L.	1
P.	Bulbous Water Hemlock — *Cicuta bulbifera* L.	1
	Cow Parsnip—*Heracleum lanatum* Michx.	2
I.	Rabbit-foot Clover—*Trifolium arvense* L.	3
	Common Cinquefoil — *Potentilla canadensis* L.	2
I.	Hairy Vetch or Tare—*Vicia hirsuta* (L.) S. F. Gray	10
I.	Field Peppergrass—*Lepidium campestre* (L.) R. Br.	1
P.	Bird Cherry—*Prunus pennsylvanica* L.f.	11
I. P.	Cypress Spurge — *Euphorbia Cyparissias* L.	1
	Hardhack—*Spiraea tomentosa* L.	1
	Canada Hawkweed — *Hieracium canadense* Michx.	1
	Field Mouse-ear Chickweed—*Cerastium arvense* L.	1
I.	Snowberry—*Symphoricarpos racemosus* Michx.	4
I. P.	Sun Spurge — *Euphorbia Helioscopia* L.	6
	Scotch Lovage—*Ligusticum scothicum* L.	2
I.	White Cockle—*Lychnis alba* Mill.	1
	Silvery Cinquefoil—*Potentilla argentea* L.	5
I.	Ribbon Grass — *Phalaris arundinacea* L. var. picta L.	6
I.	Buckthorn—*Rhamnus cathartica* L.	3
I.	Lupine—*Lupinus* sp.	2
I.	Spiny Annual Sow Thistle — *Sonchus asper* (L.) Hill	1

The next piece of survey was by rail from Montague to Mount Stewart Junction. With but little opportunity for other than trackside observation, and a diminishing number of weeds not already recorded, the following additions are culled from the "log" of this 25 mile run.

I.	Prairie Sage—*Artemisia gnaphalodes* Nutt.	1
	Willow-herb — *Epilobium* (*adenocaulon* Haussk?)	8
	Swamp Thistle—*Cirsium muticum* Michx.	6

I. Green Foxtail—*Setaria viridis* (L.) Beauv. 5
I. Yellow Foxtail — *Setaria glauca* (L.) Beauv. 1
I. Rye *Secale cereale* L.
P. Spreading Dogbane — *Apocynum androsaemifolium* L. 12
I. Small Crab-Grass—*Digitaria humifusa* Pers. 1
I. Stinkweed—*Thlaspi arvense L.* 2

From Charlottetown to Souris, a distance of 60 miles, was the stretch negotiated next. Additional weeds:

Wood Cudweed—*Gnaphalium sylvaticum* L. 5
I. Black Knapweed—*Centaurea nigra* L. 1
P. Marsh Marigold—*Caltha palustris* L. 1
I. Oats—*Avena sativa* L. 1
I. Meadow-sweet — *Filipendula Ulmaria* (L.) Maxim. 4
I. Chicory—*Cichorium Intybus* L. 5

The survey of the eastern end of the province was completed by a journey from the Charlottetown base to Murray Harbour. Again only a few species were new to the survey, the value of these trips consisting largely in their contribution to distribution and prevalence data for all the species.

I. Water Cress — *Radicula Nasturtium-aquaticum* (L.) Britten & Rendle 1
I. Small Bugloss—*Lycopsis arvensis* L. 1
Hedge Nettle—*Stachys palustris* L. 3
I. Beach Wormwood—*Artemisia stelleriana* Bess. 1
I. Garden Cress—*Lepidium sativum* L. 1
I. Pansy—*Viola tricolor* L. (perhaps not well naturalized) 1
I. Clammy Locust—*Robinia viscosa* Vent. 2

A motor trip to Brackley Beach on the north shore, and a few hours at Rocky Point, reached by ferry, added to the list the following species from the central part of the Island:

P. Low Juniper—*Juniperus communis* L., var. *depressa* Pursh. 1
I. Creeping Thyme—*Thymus Serpyllum* L. 1
Pinweed—*Lechea intermedia* Leggett 2
Rough Hawkweed—*Hieracium scabrum* Michx. 2
P. Water Arum—*Calla palustris* L. 1

The remainder of Prince Edward Island west to Tignish, was surveyed, partly going and partly coming, on one trip by rail, with the principal stop-overs, in addition to Tignish, at Summerside and Emerald Junction. Additions:

I. Flixweed—*Sisymbrium Sophia* L. 1
I. P. Purple Cockle—*Agrostemma Githago* L. 1
I. Common Wormwood — *Artemisia Absinthium* L. 1
I. Mugwort—*Artemisia vulgaris* L. 4
I. Asparagus—*Asparagus officinalis* L. 1
I. Oak-leaved Goosefoot—*Chenopodium glaucum* 1
P. Marsh Horsetail—*Equisetum palustre* L. 1
I. P. Petty Spurge—*Euphorbia Peplus* L. 1
I. Meadow Geranium—*Geranium pratense* L. 1
I. Wild Peppergrass—*Lepidium apetalum* Willd. 2
I. Small Snap dragon—*Linaria minor* (L.) Desf. 2
I. Flax—*Linum usitatissimum* L. 1
I. Spiked Loosestrife—*Lythrum Salicaria* L. 1
I. Alfalfa—*Medicago sativa* L. 1
I. Knawel—*Scleranthus annuus* L. 1
I. P. Small Nettle—*Urtica urens* L. 1

Examination of the foregoing lists will reveal some surprises, no doubt, both as to what appears, and what does not appear, and as to frequency of appearance. The human factor can be held accountable for its fair share of a margin of error; but significant differences are to be expected between such an area, maritime and insular in its setting, and another, inland let us say, a thousand miles. Even adjoining areas are not entirely homogeneous. In a brief survey, some plants, fairly common in their own season and place, will be also over-looked completely. Where local botanists have carefully worked over the flora, such deficiencies can be made good in part by reference to their records; and not the least of the "finds" of this survey were the published and unpublished lists, the collections, and the ready cooperation of these workers. MacSwain's "Flowering Plants of Prince Edward Island", and the personal assistance of Messrs. Blythe Hurst Sr., and R. R. Hurst are especially acknowledged. From these sources and from

reference to collections of the late Prof. John Macoun in the National Herbarium, the following supplementary list of weeds is compiled:

Water Hemp—*Acnida tuberculata.* Moq.
P. White Baneberry — *Actaea alba* (L.) Mill.
I. Scarlet Pimpernel — *Anagallis arvensis* L.
Great Angelica—*Angelica atropurpurea* L.
Small mistletoe — *Arceuthobium pusillum* Peck.
I. Thyme-leaved Sandwort — *Arenaria serpyllifolia* L.
P. Jack-in-the-Pulpit — *Arisaema triphyllum* (L.) Schott.
Wild Aster—*Aster* (various species).
Erect-fruited Winter Cress — *Barbarea stricta* Andrz.
Smaller Bur-marigold—*Bidens cernua* L.
Swamp Beggar-ticks — *Bidens connata* Muhl.
I. Black Mustard — *Brassica nigra* (L.) Koch.
Blue-joint Grass — *Calamagrostis canadensis* (Michx.) Beauv.
I. False Flax — *Camelina* (*sativa* (L.) Crantz?).
Bitter Cress—*Cardamine pennsylvanica* Muhl.
I. Larger Mouse-ear Chickweed — *Cerastium viscosum* L.
I. Good - King - Henry — *Chenopodium Bonus-Henricus* L.
Red Goosefoot — *Chenopodium rubrum* L.
I. Upright Goosefoot — *Chenopodium urbicum* L.
Pale Corydalis—*Corydalis sempervirens* (L.) Pers.
P. Showy Ladies' Slipper — *Cypripedium hirsutum* Mill.
I. P. Thorn-apple—*Datura Stramonium* L.
I. Wild Carrot—*Daucus Carota* L.
P. Dutchman's Breeches—*Dicentra Cucullaria* (L.) Bernh.
Boneset—*Eupatorium perfoliatum* L.
Rough Bedstraw — *Galium asprellum* Michx.
Sweet Everlasting—*Gnaphalium polycephalum* Michx.
I. Sunflower—*Helianthus annuus* L.
Sweet Grass—*Hierochloa odorata* (L.) Wahlenb.
P. Shrubby Red Cedar—*Juniperus horizontalis* Moench.
P. Swamp Laurel—*Kalmia polifolia* Wang.
I. Nipplewort—*Lapsana communis* L.
P. Pale Spiked Lobelia — *Lobelia spicata* Lam.
I. Yellow Sweet Clover—*Melilotus officinalis* (L.) Lam.
I. Creeping Mint—*Mentha gentilis* L.
I. Red Bartsia—*Odontites rubra* Gilib.
Halberd-leaved Tear-thumb — *Polygonum arifolium* L.
Dock-leaved Persicaria — *Polygonum lapathifolium* L.
Shrubby Cinquefoil—*Potentilla fruticosa* L.
P. Black Cherry—*Prunus serotina* Ehrh.
Marsh Cress—*Radicula palustris* (L.) Moench. var. *hispida* (Desv.) Robinson.
P. Small-flowered Crowfoot— *Ranunculus abortivus* L.
I. Bulbous Buttercup—*Ranunculus bulbosus* L.
P. Cursed Crowfoot—*Ranunculus sceleratus* L.
Currants and Gooseberries—*Ribes* species.
I. Wood Groundsel—*Senecio sylvaticus* L.
P. Black Nightshade—*Solanum nigrum* L.
Tall Hairy Golden-rod-*Solidago rugosa* Mill.
Late Golden-rod—*Solidago serotina* Ait.
I. Zigzag Clover—*Trifolium medium* L.
I. Field Speedwell—*Veronica agrestis* L.
I. Thyme-leaved Speedwell — *Veronica serpyllifolia* L.
I. Common Vetch—*Vicia sativa* L.
I. Slender Vetch—*Vicia tetrasperma* (L.) Moench.

In those cases where specimens were not seen the probability of occurrence was looked into before a species was admitted to the above list.

Care was exercised throughout the undertaking to have determinations of weeds as accurate as possible; and thousands of specimens seen momentarily from the train, were left unrecorded when any chance remained of a mistaken impression of identity. As a matter of fact, the observer soon develops a very quick and acute sense of color, form, size, habit, habitat and general likelihood of

occurrence, without which this phase of the survey might be open to serious question as a means of obtaining scientific information. Strictly botanical exploration relies of course, on the collecting of specimens; but for phytogeographical purposes, especially in relation to more or less familiar weeds, the value of supplementary observations, even from a railway train, is too great to be neglected, enlarging as it does, the quantitative possibilities of the project.

The total of nearly 300 species recorded above can scarcely be supposed to exhaust the Island weed flora. The survey therefore remains open for acceptance of additions, not alone of weeds overlooked, but also of migrant plants that are still finding their way into fresh fields at an alarming rate; and it is hoped that local cooperators will take an active interest in expanding, and if deemed necessary at any point, suggesting revision of, what is here presented.

The Residual Insecticidal Action of Lubricating Oil Sprays on the Pear Psylla.

WILLIAM A. ROSS

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During the past three years, orchard experiments and the experience of pear growers in Ontario have demonstrated that the cheapest and by far the most effective method of combating the pear psylla is to apply a 3% lubricating oil spray in late March or early April, after the adults have emerged from their winter quarters and before egg-laying has commenced. In discussing this method of control at the last Annual Meeting of the Entomological Society of Ontario,* we suggested that, in addition to destroying a very high percentage of the overwintering "flies" at the time of spraying, the oil continues to function as an insecticide for some time after it is applied. We mentioned that, when the trees are wet, some of the adults, which survive the application of spray, are killed by the oily film on the trees, and that some of the newly hatched nymphs may be destroyed by the oil on the wood. We also suggested that the oil may act as a deterrent.

With the object of shedding some light on the residual action of lubricating oil sprays, the following experiments were conducted during February and March, 1926, at the Dominion Entomological Laboratory, Vineland Station:

EXPERIMENT A: Gravid adults were confined from 3 to 7 days in large celluloid cages with two oil sprayed and two unsprayed pear seedlings in each cage. In nine tests 3,200 eggs (98.4%) were laid on the unsprayed and only 51 (1.6%) eggs on the sprayed wood.

EXPERIMENT B: 55 adults were confined for four days in a celluloid cage on five unsprayed and five sprayed pear twigs, and all the eggs, 703, were deposited on the unsprayed wood.

EXPERIMENT C: In each of six tests, six pairs of adults were confined for 10.2 days on sprayed wood, and another six pairs on unsprayed wood. In the "check" cages, 349 eggs (99.1%) were laid, whereas, in the cages with sprayed wood, only 3 eggs (.9%) were found.

EXPERIMENT D: 150 adults were confined for twelve days on two sprayed seedlings in a large celluloid cage. At two-day intervals unsprayed wood was introduced into and was left in the cage for two days. The psyllas had access to oil sprayed wood for twelve days and to unsprayed wood for only six days, and yet in spite of this, 97.7% (833) of the eggs were deposited on the latter.

N.B.: In all experiments we used a 3% bordeaux oil spray, prepared according to the directions given in Dominion Department of Agriculture Pamphlet, No. 66—New Series.

The results secured from the laboratory experiments, and observations, made in sprayed orchards, clearly demonstrate that the oil spray, in addition to destroying large numbers of adults, has a very important residual insecticidal action—to a very marked extent it prevents egg-laying. It is this residual action, which, no doubt, explains why lubricating oil sprays have given in our experience much cleaner-cut results in psylla control than other contact insecticides such as nicotine sulphate.

*56th Annual Report Entomological Society, Ontario.

Production of Root and Vegetable Seeds.*

A. T. KEMP

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Experimental work on a small scale was begun with this project in the fall of 1921, primarily to determine the possibility of seed production in Alberta. The Department of Agriculture has been, and is, spending a large amount of money in purchasing seed of field roots, etc., to be distributed among children of the School Fair Centres. Complaints had been received that seeds so distributed were not even true to kind or variety. After due careful consideration of the matter it was decided to select a few roots of each kind with a view to producing ultimately our own seed, because it was found that seed purchased in bulk or otherwise contained mixtures of other kinds; i.e., sugar beets and mangels with beets. This was perhaps not so very serious but it shows conditions as they then existed.

The varieties, as sold, were not true to type and sometimes not even true to name. This was the greatest difficulty, as young people did not and could not know the right type to select. Moreover, judges were having difficulty in determining when that particular variety was shown; some would be long or short, some pointed, other blunt, as in carrots. With beets, the globe type was found with the round flat, etc. Children were unable to select without difficulty, and sometimes not at all, enough of one variety with the desired character to make an exhibit.

This same difficulty was being encountered with experimental work on the plots at Olds. Varieties were not coming in even true to name. Perhaps this may be accounted for by the fact that our seeds were then coming from certain seed houses not having the desired reputation for sending out varieties true to name and type. The report made by the Dominion Horticulturist in 1923 contains some valuable data regarding experiments conducted at Ottawa. By glancing at the figures given below, a fair idea can be obtained regarding the seriousness of the situation. Not all the kinds tested are recorded here, but those that are particularly interesting at the moment.

One vegetable only comes near to being 100% true; namely, onion, with 71%. Parsnips, with 57%, and Radish with 49% are the two next highest for being 100% true to name. Beets, carrots and celery were below 50% for 100% trueness to name. In the majority of instances more than 40% of a given variety of seeds would come under the heading "under 95% true." At the time this project was under consideration, no records were kept at Olds regarding this work, but observation of tests with fewer varieties would show the same comparison. Hence, another reason for this experimental work.

It was interesting to note that certain diseases common in other countries had not shown their presence here. Particular reference might be made to Club Root (*Plasmodiophora Brassicae* Wor.) which is prevalent in most root-producing areas. Due to

*Paper given before the Western Canadian Society of Agronomy, December, 1926.

REPORT OF DOMINION HORTICULTURIST, W. T. MACOUN, 1923.

Vegetable Variety Test for Trueness. Per Cent. of Total Number True to Name.

Vegetable	Total No. Samples	100% true	99% true	98% true	97% true	96% true	95% true	Under 95% true
Beet	273	40.0	—	—	0.3	2.0	—	57.7
Carrot	298	27.0	0.6	0.6	0.3	—	—	71.5
Celery	169	36.0	—	—	—	—	0.5	63.5
Onion	391	71.1	—	0.8	6.9	6.2	3.8	11.2
Parsnip	90	57.0	—	—	—	—	—	43.0
Radish	488	49.0	0.4	3.4	1.4	2.2	1.8	41.8

APPROXIMATE ANNUAL IMPORTATION AND COST OF VEGETABLE SEEDS

	Amount Imported	Wholesale Price	Total Cost	Canadian Catalog Price per lb. (1926)
Swedes	450,000 lbs.	@ 12c	$50,400	$4.00
Mangels	400,000 "	@ 14c	56,000	2.50
Garden Beets	80,000 "	@ 23c	18,400	1.75
Parsnips	60,000 "	@ 26c	15,600	2.00
Radish	60,000 "	@ 26c	15,600	2.00
Field Carrot	30,000 "	@ 28c	8,400	1.25
Garden Carrot	40 000 "	@ 36c	14,400	2.25
	1,120,000		$182,400	

the absence of this disease it looked feasible to produce seed in large quantities without severe losses from this particular disease, as compared with the losses in other localities. There is, however, an occasional appearance of root rot while in storage, but this has been due mainly to causes which later have to a marked extent been eliminated by careful storage and discarding any roots showing this disease during the winter. Only on one occasion has Downy Mildew (*Peronospora parasitica* Pers.) been seen. This disease causes deformity of the stem and, in specimens found, certain contortions. A few minor diseases have been noted but none to cause alarm at the present. Neither have insects caused any particular trouble to roots after being set out in the open during early spring.

Previous to the war, large quantities of seeds had been imported to Canada, but during the war a campaign was put forward by the Dominion Government for farmers to produce their own seeds. After hostilities ended, this campaign was apparently forgotten, as few experiments seemed to have been carried on in connection with this work. Seeing the work had been started, no reason could be seen why it should not be carried on, especially as the cost of living was then high. In regard to importation, it is interesting to note returns as given by the Seed Branch. The data in the table above were obtained from Mr. G. S. Peart, Chief of the Markets and Seed Division during December of this year and show amount purchased and cost as delivered to Canadian points. The Report shows that approximately 1,000,000 pounds of swedes, mangels, beets, parsnips, radishes and carrots were imported at a cost of $182,400. It must be remembered of course that most of this seed would stay in Eastern Canada, only a relatively small amount coming West.

Northern Grown Seed Versus European

Western Canada has gained a reputation worthy of considerable attention by the production of cereal seed having the qualities desired and giving excellent returns when grown, particularly to the South of the line. Might not this same condition prevail with root seed? Olds has an altitude of 3,402 feet; this is considerably higher than Edmonton, Lethbridge, Saskatoon, Regina, Moosejaw or Winnipeg. If seed produced there would have the germination qualities of European-grown seed, and other factors were even, should it not be possible for Western Canada where lower altitudes prevail, to become an exporting country instead of importing? The feasibility of this policy has not yet been tried out; but if, as has been shown by experiments, seed grown in Western Canada has viability commensurate with other sources, then why should not Western Canada grow these kinds of seeds? It is true that the Western Provinces do not demand large quantities at present, but what of the future?

Another reason for conducting the work was to make a test of yields from seed grown here in comparison to that purchased elsewhere. With some other crops, such as onions, peas, etc., the policy has been adopted of selecting for earliness; with the majority of field roots this has not been considered important. Moreover, the question arises, When are field roots mature? Generally, they are harvested when danger of

TEST: OWN VERSUS PURCHASED SEED.

Yield in Tons per Acre.

Kind	Variety	1925	1926	Average	Increase
Sugar Beet	Giant White, Own............	22.85	10.75	16.80	1.066
	" " Purchased	22.35	9.118	15.734	
Mangel	Mammoth Long Red, Own.....	20.16	9.35	14.755	1.240
	" " Purchased	18.85	8.18	13.515	
Beet	Early Flat Egyptian, Own.....	9.68	17.60	13.64	1.44
	" " Purchased	9.00	15.40	12.20	
Swede	Lord Derby, Own............	24.00	30.27	27.135	3.395
	" " Purchased	21.25	26.23	23.74	
Carrot	Danvers Half Long, Own.....	9.68	14.015	11.347	1.228
	" " Purchased	9.68	11.605	10.642	

Note: Sugar Beets and Mangels were severely damaged by wind during early spring, 1926.

frost makes it imperative. Hence, selection for earliness has not been practiced. Yield, however, is an important factor because if the yield can be increased without materially increasing the cost, greater returns will be apparent and there will be a demand for such seed. The above table gives some conception as to what might be expected. Owing to severe hail storms in 1924, only two years' results can be given; namely, 1925 and 1926. The crop was completely lost in 1924, and previous to that year records were not taken, as interest was only then in the production possibilities of seed and germination.

The first line of figures gives the variety under test and grown from home-produced seed. Beneath are yields as obtained from seed purchased from seed houses, some in Europe, the others in Canada.

While these results show only yield and in most instances an increase over purchased seed, other advantages must be considered, namely: The seed was grown in Western Canada; there is an improvement in quality of roots grown, a decided advantage in producing roots true to name, type, and color, superior for the variety without the admixture of other kinds. These advantages are of particular importance to the grower and intimate that other lines might with a little effort be improved. Something worthy of attention is the improvement that has taken place in beets. During the two years as recorded, there was a distinct advantage; they were smooth, uniform in type, of an excellent deep, rich red color, uniform in size, and had what is considered variety characteristics predominating.

Methods Followed in Seed Production

When the crop is being harvested, roots of the variety chosen are all dug, and those having the desired type and qualities are selected and placed in short rows together. These are again selected even if only a few are obtained; one thing is made certain—they must be true to type. The roots are then topped carefully, about three inches of the leaves being left attached so that the crown or the root will not be injured in any way. They are then packed in boxes or barrels with soil between the roots. By not packing more than two or three layers together it is found the roots keep well and no rotting takes place. They are stored in a root cellar till early spring, when each box or barrel is turned out and the roots re-selected. This careful selection is made because so far the policy has only been to find out the possibilities of producing seed.

As soon as possible after frost is out of the ground, these roots are planted by digging holes with a spade, just deep enough to allow the crowns of the roots to protrude above the soil surface. Plants are spaced three feet apart each way; that is, a row of swedes, then mangels, etc. The length of the row is sufficient over a rod so that end plants may be discarded. No weeds are allowed to grow, particularly those of the Brassica family, because of danger in mixing similar seeds; for example, wild mustard (*Brassica arvensis*) with swedes (*Brassica Rutabagal*). So far, it has been found necessary to stake only the mangels, beets and sugar beets. Naturally, as each of them cross-fertilize, they are isolated, and none allowed to produce flowers from stalks near them.

YIELD OF SEED AVERAGE, 1923, 1925 and 1926.

Kind	Yield per Rod Row	Plants in Row	Yield per Plant	Estimated yield per Acre (lbs.)
Sugar beet	1 lb. 9 oz.	5	5 oz.	1375
Swede	2 lb. 8 oz.	5	8 oz.	2400
Mangels	2 lb. 7 oz.	5	6 1/5 oz.	2145
Parsnip	1 lb. 2 oz.	5	2 2/5 oz.	990
Beet	1 lb. 2 oz.	5	3 1/5 oz.	1000
Carrot	1 lb. 5 oz.	8	4 1/5 oz.	1155

Harvesting

With mangels, beets, sugar beets and swedes, the whole of the plant is cut down, preferably in the early morning, spread on the ground to dry, then sacked in large seed sacks, labelled, and placed in a dry airy shed to await threshing. The latter has so far been done by hand. After threshing, they are cleaned with a small clipper fanning mill and the seeds are weighed and stored with the name, variety and year on labels—one inside, the other out. Carrots and parsnips are harvested by clipping off the mature umbels as they mature, storing them in labelled sacks and others added from time to time.

The amount of seed produced per plant and rod row is given above. The results are for 1923, 1925 and 1926, no seed being produced during 1924. Owing to a small area being planted, it has been considered advisable to give estimated yield per acre, but based on what has been produced in rod rows.

During this year sufficient roots were selected from those grown in the tests, for planting larger areas, where it is hoped that actual cost of production and accurate yields per acre may be obtained, as well as growing sufficient seed possessing desired type and uniformity throughout for distribution among the School Fair Centres.

In conjunction with the production of field root crops there have also been carried on tests and selections of other seed such as peas, beans, onions, and a number of flowers. So far, there has not been sufficient work done to give any data, or yet form conclusions regarding the latter.

The Improved Hoyberg Method for the Testing of Milk and Cream for Butter-fat.*

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From time to time attempts have been made to devise rapid methods for determining fat in milk on the lines of the Gerber test, but avoiding the use of strong sulphuric acid. Every user of the Gerber test knows that when the acid and milk are mixed in the butyrometer, considerable heat and consequent pressure are developed which may cause serious accidents through the bursting of butyrometers with unnoticed flaws, or through inexperienced or incautious handling in one way or another.

Thus far the various neutral or alkaline methods designed to overcome the above mentioned objection have not achieved lasting success.

In the case of certain of the alkaline methods this is owing to the fact that their accuracy is greatly affected by the degree of exactness with which a small amount of

*For the translation of this article, an abstract of the complete paper, I am indebted to Dr. P. S. Arup.

Amyl or Isobutyl alcohol used is measured.

The original method designed by Hoyberg was also shown eventually to be subject to the same limitation but owing to the novel advantage which it offered in dispensing with the use of the centrifuge, it found some support. The present form of this method (known as the 1926 model) is free from the objection in question as the small proportion of alcohol used is not measured separately but is incorporated with the larger bulk of alkaline liquid, so thus the effect of any error is greatly minimized. 6.5 cc of the mixed liquid are used for a butyrometer charge with 9.7 cc of milk, and it has been shown that an error of 0.2 cc either way on the 6.5 cc (representing about half an inch above or below the mark on the measuring pipette) will not noticeably affect the results.

The above amounts of milk and liquid are measured into the specially designed butyrometer and thoroughly shaken together; the butyrometer is placed in a water bath at about 50° - 52° C. (122° - 126°F.) for three minutes after which it is twice turned upside down; the three minutes standing and the turning are to be repeated once more, when the butyrometer is left in the warm water for 10 to 15 minutes; the fat percentage may be read off in the usual way.

Special directions are given as to the best and quickest method of shaking and turning, as this is a very important part of the process, but it is not necessary to give details here. It will be gathered that the tests require a certain amount of personal attention during most of the process, though facilities are provided for dealing simultaneously with a number of tests, in addition to which the method may be somewhat shortened by the use of the centrifuge if so desired. In any case the comparatively low temperature of the water bath makes for convenience in handling the butyrometers throughout the process, which constitutes an advantage over other similar methods.

This modified method can also be used in cases where preservatives have been added to the milk or cream, a feature marking distinct progress on the older form of the Hoyberg method.

The Hoyberg method is also applicable to the testing of cream in which case it is somewhat more expeditious than is the case with milk.

As regards the accuracy of the method, a number of tests have been carried out to compare the results with those obtained by the Gerber method and the very accurate Rose-Gottlieb method as a standard, and very satisfactory agreements have been obtained. It was found that for very rich milks with about 7 to 8 per cent of fat, the Hoyberg results are slightly more accurate than the corresponding Gerber results, while for poor milks with 1 to 2 per cent of fat, the balance is slightly in favour of the Gerber method. For normal milks there appears to be very little choice as regards accuracy between the two methods.

Taking a normal sample of milk, 24 tests by the Hoyberg method gave an average figure of 3.46 per cent of fat, and a further 24 tests on the same sample gave an average of 3.48 per cent by the Gerber method. The Hoyberg method showed a maximum variation from the mean of these 24 tests of 0.06 and an average variation of 0.032. The corresponding figures for the Gerber method were 0.08 maximum variation, and 0.027 for the mean variation.

If separated milk is to be tested by the Hoyberg method, the centrifuge must be used. In testing cream, the Hoyberg method was found to give somewhat better results than the Gerber method.

In consideration of the above facts it would appear that the Hoyberg method in its improved form is well worth consideration as a rapid method of testing milk for fat, especially in the hands of those who have no scientific training. Where for any reason, a centrifuge is not available, as on most farms, the adoption of the Hoyberg method would appear to be of the greatest assistance to the milk-producer.

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RÉDACTEUR—H. M. NAGANT

La Production actuelle des Engrais Azotés Synthétiques.

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Il y a quelques années, vers la fin de la grande guerre, on pouvait prévoir une révolution dans l'emploi des engrais azotés en agriculture, aussitôt que le mouvement irrésistible donné à l'application industrielle de la synthèse des composés azotés, par les besoins insatiables en explosifs, pourrait s'aiguiller vers les oeuvres de paix. Sans faire de bruit, ni répandre de sang, sauf peut-être à l'occasion d'une catastrophe mémorable causée, en 1921, par l'explosion de plusieurs milliers de tonnes de produits azotés synthétiques dans la grande usine allemande d'Oppau, faisant près de 1,500 victimes, cette révolution ne s'acomplit pas moins effectivement, et cela pour le plus grand bénéfice de l'agriculture. Sa manifestation la plus sensible, du point de vue pratique de l'agriculteur, se traduit sans doute par l'abaissement du prix des engrais azotés qui n'aura pas manqué, ce printemps surtout, de frapper tous ceux qu'intéressent le commerce et l'emploi des engrais commerciaux.

Alors que la plupart des marchandises se vendent encore aujourd'hui à un prix qui est de 50% plus élevé que celui de 1914, l'azote fait exception puisque nous pouvons obtenir du sulfate d'ammoniaque à 20% d'azote, en Canada, aux environs de $50.00 la tonne, ou 12.5c la livre d'azote, tandis qu'avant la guerre, il fallait plutôt tabler sur respectivement $70.00 et 17.5c.

A ce propos, il sera peut-être intéressant de faire une petite récapitulation de l'état actuel de la production des trois formes fondamentales de composés azotés synthétiques déjà bien connues, qui sont; ainsi que tout le monde le sait: *l'acide nitrique, la cyanamide de calcium* et *l'ammoniaque synthétique,* et des formes d'engrais dérivés, assez variées, auxquelles ont surtout donné naissance les deux derniers composés que l'on vient d'énumérer, depuis que la puissante industrie nouvelle, sortie de la guerre avec une capacité de production énorme, s'attache surtout à répondre aux besoins de l'agriculture. Commençons d'abord par:

L'Acide Nitrique Synthétique

Il n'y a pas grand'chose de nouveau à rapporter relativement aux conditions de fabrication par synthèse directe de ce composé de base. Rappelons que les premiers essais d'oxydation de l'azote de l'air dans le four électrique datent de 1903 et que ce furent deux ingénieurs norvégiens, Birkeland et Eyde, qui mirent au point le premier four à arc, portant leur nom, dans lequel s'opère l'oxydation de l'azote de l'air à une température de 3,000° réalisée par les immenses étincelles jaillissant entre deux électrodes placées dans un courant alternatif de haut voltage, utilisant jusqu'à 4,000 kilowatts.

Le mélange d'air et de bioxyde d'azote, N_2O_2, ainsi obtenu, est alors refroidi à température inférieure à 600°, afin de permettre la deuxième étape d'oxydation, qui doit donner du peroxyde d'azote, suivant la réaction:

$$N_2O_2 + O_2 = N_2O_4$$

Enfin, l'air chargé des vapeurs rutilantes de N_2O_4 est envoyé dans des tours d'absorption

où l'hydratation du peroxyde d'azote engendre de l'acide nitrique.

Certaines modifications de détails apportées au four original Birkeland et Eyde ont donné, par la suite, le procédé Schönherr, employé concurremment avec le premier, en Norvège; le four Naville et Guye, utilisé en Suisse; le four Pauling, en Allemagne; le four Rossi mis en application dans les usines italiennes d'oxydation de l'azote. (2).

Dans ces derniers temps, certains perfectionnements ont été apportés dans le rendement énergétique du procédé à l'arc, lequel dès à présent, ne consomme plus que 40 kilowatts-heure par kilogramme d'azote fixé. Ceci a été réalisé en ajoutant de l'oxygène à l'air introduit dans le four, de manière à obtenir un mélange contenant de l'azote et de l'oxygène en proportions égales.

La Société "L'Azote Français", poursuit aussi des recherches en vue de réduire de 1/500 à 1/30,000 de seconde, la durée du séjour du gaz dans l'arc, et, par suite, de diminuer le taux de dissociation des oxydes d'azote formés. (1)

Il semble cependant, que la fabrication directe de l'acide nitrique et des nitrates, par oxydation de l'azote, doive céder le pas à celle de la cyanamide et de l'ammoniaque. S'il est vrai qu'elle n'utilise comme matière première que les éléments de l'air et n'a besoin que de pouvoirs d'eau comme source d'énergie, il y a toujours à tenir compte que ce procédé fait un gaspillage effréné de l'énergie mise en oeuvre, et, si même on arrive à réaliser quelques perfectionnements dans l'emploi de l'arc, à le rendre plus économique, celui-ci n'est pas illimité et est en grande demande d'autre part. Aussi, peut-on constater aujourd'hui, que la synthèse directe de l'acide nitrique n'est pas beaucoup développée dans les pays autres que la Norvège qui en fut le berceau grâce à la présence d'immenses pouvoirs d'eau sans autre emploi. On n'a signalé après la guerre que l'établissement de quelques petites fabriques nouvelles d'acide nitrique par le procédé à l'arc voltaique, grâce généralement à des subventions officielles, aux Etats-Unis, en Angleterre et une en Italie. Leur rendement est resté de peu d'importance comparé à celui des grandes installations pour la production de la cyanamide calcique ou de l'ammoniaque synthétique. On prévoit même que la Société norvégienne substituera graduellement la fabrication de la cyanamide à celle de l'acide nitrique dans ses installations.

Les plus récentes statistiques, pour l'exercice annuel prenant fin au 31 mai 1926, indiquent une production mondiale de 30,000 tonnes d'azote nitrique synthétique, soit l'équivalent de 150,000 tonnes de sulfate d'ammoniaque à 20% d'azote, dont la majeure partie provient des usines norvégiennes, qui le vendent généralement sous forme de nitrate de calcium.

La Cyanamide de Calcium et ses Dérives

L'industrie de la cyanamide de calcium, malgré les défauts que présente le produit employé comme tel en agriculture, s'est beaucoup plus généralement répandue dans les différents pays et accuse une progression bien supérieure dans la production.

C'est ainsi que les dernières statistiques connues nous apprennent que l'on peut estimer à un total de 150,000 tonnes d'azote fixé ou l'équivalent de 750,000 tonnes de sulfate d'ammoniaque, la production totale de la cyanamide de calcium. Les principaux pays qui ont contribué à cette production sont:—l'Allemagne, 238,000 tonnes en 1922; la Pologne, 35,754 tonnes; le Canada, 65,-100 tonnes; le Japon 121,757 tonnes; la Suisse, 25,000 tonnes, etc. (Les chiffres pour ces derniers pays représentant les quantités fabriquées pendant l'exercice 1925-1926, (3)

La fabrication de la cyanamide pourrait, si le besoin s'en faisait sentir, se développer dans des proportions beaucoup plus grandes encore. C'est ainsi que dans les énormes établissements de Muscle-Shoals, état d'Alabama, où le gouvernement des Etats-Unis enfouit plus de 75 millions de dollars pour y organiser la fabrication des composés synthétiques, en vue des besoins éventuels de la défense nationale, on prévoyait une production annuelle de 220,000 tonnes de cyanamide (4). On sait que tout le projet a été abandonné depuis et que la question de disposer de ces installations inachevées, qui furent sur le point d'être cédées pour cinq millions au grand industriel Henry Ford, fait depuis plusieurs années l'object de discussions interminables.

Dans d'autres pays, tels que la France par exemple, la production reste aussi à un niveau bien inférieur à celui qu'il pourrait atteindre au besoin; l'Allemagne possède les grandes usines de cyanamide de l'Allemagne Cen-

trale, situées à Priesteritz, et celles de la Bavière qui sont équipées pour produire un total de 80,000 tonnes d'azote combiné, soit environ 400,000 tonnes de cyanamide à 20% d'azote, par an.

Remarquons que les matières premières consommées par cette industrie sont: de la chaux, du coke et de l'azote. La chaux et le coke servent à obtenir le carbure de calcium par chauffage à haute température dans le four électrique, suivant la réaction:—

$$CaO + 3C = CaC_2 + CO$$

Le carbure de calcium, qui autrefois ne servait qu'à la production du gaz acétylène, est alors chauffé entre 900 et 1200° et soumis à l'action d'un courant d'azote, lequel s'y combine directement et en sépare du carbone à l'état libre:

$$CaC_2 + N_2 = CaCN_2 + C + 46 \text{ Calories.}$$

La première réaction est fortement endothermique; la deuxième, ainsi qu'on le voit, a lieu avec un dégagement de 46 calories; aussi, la chaleur appliquée ne sert qu'à amorcer la combinaison qui se continue ensuite sous l'effet de son propre dégagement calorifique.

Pour fixer une livre d'azote il faut quatre livres de carbure. Les dépenses d'énergie sont de trois chevaux-an par tonne métrique, (2,200 lbs.) d'azote fixé, dans le procédé Frank et Caro, comparativement à 11 chevaux-an dans la méthode d'oxydation directe par l'arc électrique. (5)

Inconvenients de la Cyanamide comme telle

Dès que la cyanamide prit cours parmi les engrais azotés, on lui reprocha plusieurs défauts, tels que:

1—D'être d'un maniement peu commode et désagréable lors de l'épandage.

2—De se montrer très toxique pour les plantes dans certaines circonstances et par conséquent aléatoire dans ses effets.

On a remédié au premier défaut de différentes façons: d'abord, en incorporant une certaine proportion d'huile de goudron à la poussière noire et fine comme du noir de fumée que représente la cyanamide pulvérisée à l'état naturel, et, plus récemment, en l'offrant à l'état granulée, ou moulée en forme de petite bâtonnets dont l'épandage est plus aisé.

Transformations Chimiques Subies par la Cyanamide

Un défaut plus grave est celui des transformations chimiques que subit éventuellement la cyanamide, lors de sa conservation ou dans le sol, donnant naissance à des corps azotés non assimilables et toxiques pour les plantes, tels que la dicyanamide.

L'étude de ces transformations a fait l'objet des recherches de beaucoup de savants, et l'on sait que, normalement, la cyanamide de calcium est hydrolysée par l'humidité du sol et forme de la cyanamide libre et de l'hydroxyde de chaux suivant le réaction:

$$CaCN_2 + 2H_2O = H_2CN_2 + Ca(OH)_2$$

La chaux hydratée se change rapidement en carbonate de chaux et la cyanamide libre, qui est toxique pour les plantes, ne tarde pas à être transformée en urée, sous l'action des bactéries du sol, par fixation d'une molécule d'eau:

$$H_2CN_2 + H_2O = CO\begin{matrix}\diagup NH_2 \\ \diagdown NH_2\end{matrix}$$

L'urée elle-même devient bien vite la proie des bactéries ammonisantes qui la font passer à l'état de carbonate d'ammoniaque par une nouvelle étape d'hydratation:

$$CO\begin{matrix}\diagup NH_2 \\ \diagdown NH_2\end{matrix} + 2H_2O = (NH_4)_2CO_3$$

Suivant des expériences faites par Brioux, en 1924, cette transformation de l'urée en carbonate d'ammoniaque s'achève au bout de 48 heures dans un sol fertile et suffisamment humide. Mais, en dehors du sol, pendant la conservation de la cyanamide, celle-ci se polymérise facilement en dicyanamide $H_4C_2N_4$, résultant de l'union de deux molécules. Cette transformation semble être favorisée par la présence des bases alcalino-terreuses ainsi que par le moulage sous forme de bâtonnets qui détermine sous une assez forte pression une hydratation partielle du produit.

La conversion peut être très profonde; des analyses de sacs de cyanamide moulée, conservés d'une année à l'autre, faites à la Station Agronomique de Rouen (France), ont montré que 77% de l'azote total était passé à l'état de dicyanamide et 15% à l'état d'urée, tandis qu'il n'en subsistait plus que des traces sous forme de cyanamide.

La dicyanamide elle-même peut s'hydrater sous l'influence de divers agents chimiques, et notamment de l'acide sulfurique dilué, pour donner naissance à une base forte, appelée guanylurée, suivant la réaction:

$$H_4C_2N_4+H_2O=H_6C_2N_4O \text{ ou } \begin{array}{l} \quad\quad\; NH_2 \\ CO < \\ \quad\quad\; NH \\ CNH < \\ \quad\quad\; NH_2 \end{array}$$

Cette transformation se constate par exemple lorsqu'on traite de la cyanamide de calcium contenant de la dicyanamide par de l'acide sulfurique.

La dicyanamide, outre qu'elle semble nette ment toxique pour la plupart des plantes, est très lente à se transformer en ammoniaque; elle retarde et arrête même complètement la nitrification de l'ammoniaque. Selon Brioux, il semble en être à peu près de même de la guanylurée; aussi, dans des expériences de culture en pots faites avec addition d'azote sous forme de ces deux composés, les rendements furent inférieurs à ceux des cultures dans les pots témoins qui n'avaient pas reçu d'azote. (6).

Engrais Preparés par la Conversion de la Cyanamide de Calcium

Sels Ammoniacaux — Ammo-Phos—Urée — Phosphoazote.

Les inconvénients qu'offre l'emploi de la cyanamide ont bien vite incité l'industrie à chercher les moyens de la convertir en composés plus avantageux comme engrais.

Dès le début, l'expérience a démontré que la cyanamide de calcium pouvait être hydrolisée sous l'influence de la vapeur d'eau surchauffée dans une autoclave et fournir de l'ammoniaque, d'après la réaction:

$$CaCN_2 + 3H_2O = 2NH_3 + CaCO_3$$

Cette ammoniaque peut alors être fixée sous forme de sels ammoniacaux divers, tels que le sulfate d'ammoniaque, le nitrate d'ammoniaque, le chlorhydrate d'ammoniaque ete. Parmi les sels ammoniacaux dérivant de la cyanamide, lancés sur le marché des engrais depuis quelques années, il faut mentionner le produit baptisé du nom de "Ammo-Phos, préparé par les Usines de la AMERICAN CYANAMIDE COMPANY, de Niagara, Canada, lequel est donc un engrais à deux éléments: azote et acide phosphorique, préparé tout simplement en fixant l'ammoniaque au moyen l'acide phosphorique.

Pour cela, on traite du phosphate minéral par un excès d'acide sulfurique, de manière à obtenir un mélange d'acide phosphorique et de sulfate de chaux; la solution du premier est séparée du second par filtration et sert à absorber l'ammoniaque en proportions voulues. La solution de phosphate d'ammoniaque est ensuite évaporée jusqu'à siccité et laisse un résidu granuleux, de teinte grisatre, ressemblant au superphosphate ordinaire.

L'AMERICAN CYANAMIDE CO. offre deux variétés d'Ammo-Phos: une première qui titre 13% d'ammoniaque ou 10.7% d'azote, et 48% de P_2O_5, correspondant à près à la formule du phosphate monoammonique: $NH_4H_2PO_4$; une autre renferme environ 20% de NH_3 ou 16.45% d'azote, et 20% de P_2O_5 et semble être formée, en bonne partie, de phosphate diammonique et de matières insolubles.

Les deux variétés représentent des engrais bivalents, très concentrés et par conséquent avantageux pour l'expédition à longue distance, par l'économie qu'ils font réaliser sur le prix du transport.

Franklin E. Allison, de la Station Expérimentale de l'Etat de New Jersey (8), après des études élaborées sur la valeur engrais de l'Ammo-Phos comparé à des fertilisants azotés et phosphatés sous forme de matérieux simples, conclut que ce produit a la même valeur que des quantités équivalentes d'azote à l'état de sulfate d'ammoniaque jointes à de l'acide phosphorique à l'état de superphosphate. Le phosphate d'ammoniaque nitrifie et est absorbé par les bactéries et les plantes avec beaucoup de facilité. L'auteur conclut encore que par suite de sa concentration, il faut évidemment être prudent dans l'application de cet engrais dans les rangs de semis.

Un autre dérivé de la cyanamide est l'engrais dénommé PHOSPHOAZOTE, préparé d'après le procédé de la "Société Suisse des produits azotés, de Martigny." Ici, la cyanamide est d'abord convertie en sulfate d'urée. Pour cela, on la met en suspension dans de l'eau, en présence d'un courant de CO_2 qui fait précipiter le $Ca(OH)_2$ pendant que se dégage H_2CN_2, cyanamide libre; ensuite il est ajouté du H_2SO_4 qui, en agissant comme catalyseur, hydrate la cyanamide à l'état d'urée:

$$H_2CN_2 + H_2O = CO(NH_2)_2$$

L'urée se combine avec l'acide sulfurique. La solution de sulfate d'urée contenant un excès de H_2SO_4 est alors employée pour attaquer des phosphates minéraux, et il y a formation d'un superphosphate d'urée auquel on a donné le nom de Phosphoazote.

Dans cette opération, de petites quantités de de dicyanamide qui se sont formées lors de la mise en suspension sont transformées en guanylurée, mais elles sont peu importantes quand le travail est fait dans de bonnes conditions.

Lorsqu'on mélange du superphosphate avec de la cyanamide, il y a également transformation d'une partie de l'azote cyanamidique en urée, mais l'expérience a démontré que, outre l'inconvénient d'une forte rétrogradation du phosphate monocalcique avec la chaux de la cyanamide, il y a généralement formation de proportions considérables de dicyanamide et de guanylurée, de la manière qui a été expliquée plus haut. Aussi cette pratique qui avait été adoptée par quelques fabricants d'engrais, dans le but d'obtenir l'azote à l'état uréique, est-elle fortement déconseillée aujourd'hui.

(à suivre)

ACTIVITES DES SECTIONS

Section de Québec

La section de Québec se fait remarquer par une activité de bon aloi. Le samedi, 14 mai, elle organisait un autre déjeuner-causerie au restaurant Kerhulu, à Québec.

Parmi ceux qui étaient présents on remarquait M. le Dr. Pépin, vice-président, M. Georges Maheux, entomologiste provincial, MM. Jean-Charles Magnan, Emile Gauthier, le Dr. Bédard, A. Desautels, Rousseau, Baribeau, Roy, agronome de Lotbinière, Chabot, Auger, Lafrenière, Belzile, etc.

Le conférencier fut M. Georges Maheux, entomologiste, qui donna une belle leçon d'histoire naturelle, en parlant d'un modeste savant dont le nom a survécu: l'abbé Léon Provancher.

M. Maheux fit un magnifique portrait de ce Linné canadien, ce journaliste fécond, ce polémiste courageux, cet historien et narrateur intéressant, ce prêtre dévoué que fut l'abbé Provancher. "Qui n'a entendu parler", dit-il, "de la Flore de Provancher, du Naturaliste Canadien, deux oeuvres colossales et si régionalistes? A elles seules elles illustrent l'abbé Provancher. Avant qu'il y eût des agronomes et que la politique de vulgarisation agricole fût organisée par l'hon. M. Caron, M. Provancher faisait de l'agronomie à sa manière en plantant les premiers vergers du comté de Portneuf, en répandant les meilleures variétés de fruits pour notre climat. Ce travail pratique eut sa répercussion et ont vit, suivant les traces du brave curé de Portneuf, les Huard, les Laflamme, les Bélanger, les Crevier et les Saint-Cyr, ce qui prouve que la vraie science, basée sur une étude sérieuse, une observation attentive, un zèle inlassable, enfin un patriotisme des plus purs et des mieux éclairés, finit toujours par porter ses fruits même dans un entourage et à une époque non préparés à toutes les innovations pratiques appliquées à l'agriculture. Car n'oublions pas la mentalité de 1850".

M. Jean-Charles Magnan, chargé par le docteur Pépin de remercier le conférencier, fit d'heureuses suggestions pour l'enseignement élémentaire agricole dans les écoles de campagne. Les assistants ont gardé deux bons souvenirs de cette réunion joyeuse et intéressante: 1o comment l'histoire naturelle a pu former un abbé Provancher, agronome de coeur et d'esprit, car d'agronome de nom, il n'y en avait pas alors; 2o ce qu'a fait pour l'avancement de l'agriculture et de sa race un naturaliste d'une pareille envergure.

NOUVELLES DE NOS MEMBRES

Nous apprenons que monsieur Stanislas Chagnon précédemment du Service fédéral de l'élevage, a été nommé Sous-Chef du Service d'élevage de la province de Québec.

Monsieur Alfred Savoie, qui remplinait les fonctions d'Inspecteur des fermes de démonstration, du Service de la Grande Culture de la province de Québec, a accepté la direction du "Bulletin de la ferme".

On nous communique, au moment de mettre sous presse, que le Révérend Père Léopold, Directeur de l'Institut Agricole d'Oka, a reçu le titre de "Docteur en Sciences Agricoles", honoris causa, de l'Université de Montréal. Nous adressons toutes nos félicitations au Révérend Père Léopold pour le grand honneur qui lui échoit.

Conditions d'assimilation des engrais Phosphatees, par M. Gregoire, professeur à l'Institut Agronomique de Gembloux (Belgique).

Les anciens physiologistes pensaient que la plante exigeait pour se développer, des solutions relativement concentrées et que, pour se procurer ces solutions, elle devait nécessairement émettre des acides par ses racines pour solubiliser les phosphates insolubles du sol. Tout cela était erroné, mais les nouvelles données de la physico-chimie et de la chimie colloïdale apportent une lumière nouvelle sur la question.

La définition nouvelle du caractère acide et de la force des acides montre que la plante ne peut exercer qu'une action dissolvante directe nulle ou très limitée.

D'autre part, la chimie colloïdale fournit des règles relatives à la dissolution des substances fixées par adsorption qui paraissent très différentes de celles qui s'appliquent aux combinaisons chimiques ordinaires.

Enfin, on a constaté que la plante peut prendre un développement normal aux dépens de solutions très diluées, ne comportant que quelques milligrammes de substances actives par litre.

Des essais effectués à Gembloux montrent que l'acide phosphorique actif du sol se trouve très probablement sous forme d'un complexe colloïdal à base d'humate de chaux. La chaux de ce complexe serait liée moins intimement que l'acide phosphorique et sa dissolution dans l'eau aurait pour effet de libérer ce dernier.

Cette théorie fournit une explication extrêment du simple mécanisme de l'absorption de l'acide phosphorique par la plante. Elle serait due à la destruction du complexe colloïdal par suite de l'insolubilisation de la chaux par un acide organique, (l'acide oxalique généralement), à l'intérieur du poil radical. Au début de la végétation, la plante se trouve placée dans un cercle vicieux. Pour assimiler l'acide phosphorique nécessaire à la formation des feuilles, elle a besoin d'acide oxalique qui devrait être produit par ces feuilles. Quand l'appareil foliaire est constitué, elle peut s'attaquer au complexe colloïdal et même aux combinaisons chimiques plus insolubles.

Des essais culturaux exécutés à Gembloux montrent qu'il en est bien ainsi. Les engrais phosphatés agissent surtout au début de la végétation.

Les sels calciques solubles, qu'ils soient ajoutés au sol ou qu'ils proviennent de doubles décompositions produites par des sels non calciques appliqués, augmentent la stabilité du complexe colloïdal et annihilent plus ou moins l'action de l'acide fixateur de chaux des racines; ils peuvent ainsi agir sur l'utilisation de l'acide phosphorique.

Le mode de fixation de l'acide phosphorique lie fortement ce dernier tout en le laissant disponible pour la végétation.

L'acide phosphorique plus ou moins soluble dans l'eau appliqué au sol sous forme d'engrais est rapidement précipité par suite d'une série de réactions complexes. Il n'y a de différence entre les engrais peu solubles et ceux qui le sont facilement que la rapidité de le réaction. Les phosphates très insolubles, la plupart des phosphates naturels, ne donnent que des solutions aqueuses de concentration inférieure à celle des solutions fournies par les sols les plus pauvres. Ils ne peuvent donner des résultats que dans les sols très pauvres.

Le cultivateur doit constituer ou maintenir le complexe colloïdal de ses terres. De là, la nécessité des fumures organiques et des chaulages concurremment avec les engrais phosphatés. La fumure organique est fournie par le fumier ou les engrais verts dont la production est déterminée par la nature du sol, les conditions climatériques et le milieu économique. La situation est donc variable à l'infini.

Les engrais phosphatés ne viennent que comme supplément à ces fumures de base et les quantités à employer sont par conséquent très variables. Il n'est pas rare que les quantités optima soient dépassées dans la pratique.

Pour obtenir une bonne utilisation, les engrais phosphatés doivent être choisis selon le sol et les cultures, être employés annuellement par petite dose et épandus avant le semis ou très tôt au printemps. L'application à proximité des racines est probablement très favorable à une bonne utilisation.

Concerning the C.S.T.A.

NOTES

Dr. C. A. Zavitz (O.A.C. '88), Professor of Field Husbandry at the Ontario Agricultural College, is retiring this summer, after over forty years of useful service at that institution. His many friends in professional work unite in wishing him many years of happiness.

Rev. Father Leopold, Director of the Oka Agricultural Institute, has been awarded the degree of Doctor of Science in Agriculture (honoris causa) by the University of Montreal.

C. Leonard Huskins (Alberta '25) has been appointed to the research staff of the John Innes Horticultural Institution, Mostyn Road, Merton, S.W.19, London, England. He is continuing his work with oats, as well as a problem with wheat and one or two studies of a horticultural nature. The Institution is under the Direction of Sir Daniel Hall, formerly of Rothamsted, who has succeeded the late William Bateson.

G. G. Moe (Macdonald '12) has been granted one year's leave of absence by the University of British Columbia, and is taking post graduate work towards his Doctorate degree at Cornell University.

Stanley Wood (O.A.C. '23) has been transferred as Agricultural Representative from Moncton, N.B., to St. Stephen, N.B.

A. E. MacLaurin (O.A.C. '14) has been appointed Live Stock Superintendent for New Brunswick and left for Fredericton on May 15th. He was formerly District Sheep and Swine Promoter under the Dominion Live Stock Branch.

James Bremner, Jr., has been appointed Maritime Field Man for the Canadian Jersey Cattle Club. His headquarters will be at Fredericton, N.B.

F. S. Thomas (O.A.C. '22) was recently transferred from Port Arthur to Dutton, Ont., as Agricultural Representative.

R. C. Parent (O.A.C. '23) is Supervisor of Illustration Stations, with headquarters at the Dominion Experimental Station, Charlottetown.

Fraser Ross (O.A.C. '22) has resigned his position as Agricultural Representative at Simcoe, Ont., and has accepted a position with the Maple Leaf Milling Company at Toronto.

C. W. Buchanan (O.A.C. '11) has been transferred as Agricultural Representative fom St. Thomas to Port Arthur, Ont.

D. B. Flewelling (Macdonald '12) has been appointed Agricultural Representative at Bridgewater, N.S.

F. W. Walsh (O.A.C. '22) has been appointed Agriculturist for Eastern Canada, under the Colonization Department of the Canadian National Railways. He was Professor of Animal Husbandry at the Nova Scotia Agricultural College, Truro.

F. X. Gosselin (Laval '23) is now at the Dominion Experimental Station, Kapuskasing, Ont.

G. L. Giasson (Montreal '25) is at the Dominion Entomological Laboratory, Chatham, Ont,

CONVENTION NOTES

The Report of the Committee on Educational Policies (chairman, President L. S. Klinck) will be presented to the Convention at 11.30 a.m. on Thursday, June 16th. Through an oversight, this was omitted from the Convention programme.

The Convention programmes were mailed to all members of the Society on May 23rd.

The Deputy Minister of Agriculture for Ontario has advised the General Secretary that Mr. R. S. Duncan wil officially represent that Department at the Convention.

The General Secretary will attend local branch meetings at Fort William on June 6th, Winnipeg on June 7th and Saskatoon on June 8th, en route to Vancouver. He will be accompanied by Mr. L. P. Roy, President-elect

of the Society, who is taking this opportunity of meeting western members of the Society.

The annual financial statement, to be presented at the Convention, will show an encouraging surplus for the year which closes on May 31st. The Society has a cash balance of slightly more than $2,100 which is very satisfactory, especially as the fee was reduced from $6.00 to $5.00 at the beginning of the year. The cash balance at the beginning of the year was $1096.00.

It is expected that considerable time will be devoted to the editorial policy of the Society's official organ. It is becoming more and more apparent that *Scientific Agriculture* must be prepared to take its place among technical journals and that several changes will have to be made in its appearance and make-up if it is to be creditable to the agricultural profession in Canada. No change can be made until the completion of the current volume.

Members who have resolutions to bring before the Convention, or who wish to introduce any subject for discussion, must notify the General Secretary before May 15th. Address him at the Hotel Vancouver, Vancouver, B.C.

A complete report of the Convention will be published in the August issue of *Scientific Agriculture,* which will be in the mails on July 31st. The dates of the Convention, and its distance from Ottawa, prevent publication of the proceedings in the isssue at the end of June.

VACANCIES IN DOMINION DEPARTMENT OF AGRICULTURE

The Civil Service Commission at Ottawa has advertised the position of Assistant Agricultural Bacteriologist for the Experimental Farms Branch. The initial salary is $1,920 per annum, with increases at the rate of $120 per annum up to a maximum of $2,400. Qualifications include post graduate specialization in bacteriology with particular reference to dairy bacteriology. Applications must reach the Civil Service Commission by June 14th.

C.S.T.A. BANQUET ON JULY 28th.

During the week of the World's Poultry Congress, the Eastern Ontario Branch will be hosts at an International Banquet, to be held on the Quebec side of the Ottawa River, some five miles from the capital. Those who have the preliminary arrangements in hand claim that it will be the biggest event in the history of the Society. The date is to be July 28th. The cost will be either $3.50 or $4.00 per cover, including wines, transportation from Ottawa, entertainment, orchestra, etc.

It is intended to send invitations to a considerable number of the delegates to the Poultry Congress and the table plan will be closed as soon as three hundred acceptances have been received.

This notice is an invitation to every C.S.T.A. member. If you intend to be present at the banquet, please send notice to that effect *at once* to Mr. M. B. Davis, President, Eastern Ontario Branch, Experimental Farm, Ottawa.

Self-fertilization in Timothy.*

SIDNEY E. CLARKE†

Assistant Dominion Agrostologist, Swift Current, Sask.

INTRODUCTION

Selection has been practised for many years in the improvement of cultivated crops. An important advance was made when Vilmorin demonstrated the value of basing the selection of individual plants on the performance of their progeny. Nilsson and Hays used this method in their selection work and instituted the pedigree culture system in the breeding of cereals. It was not until Johannsen preformed his classic experiment with beans that the full significance of the pedigree method of breeding normally self-fertilized plants was appreciated. Johannsen gave his results a Mendelian interpretation, and formulated his definition of a pure line as the progeny of one or more self-fertilizations from a single homozygous ancestor. The far-reaching importance of the pure-line concept in the breeding of normally self-fertilized crops was easily apparent, and its application by plant breeders to the improvement of small grains soon led to standardized methods of procedure in the breeding of these crops.

With cross-fertilized plants, the problem of producing improved varieties is a more difficult one as under ordinary crop conditions the selection of the more desirable plants must be made on the basis of the appearance of the mother plant only. Owing to the heterozygous character of normally cross-fertilized crops, single plant selections cannot be depended upon to give uniform and true-breeding progeny.

Previous to the 20th century, progress in the improvement of cross-pollinated crops was retarded by the persistence of the Knight-Darwinian conception that "nature abhors perpetual self-fertilization" and that plants dependent upon it are in danger of ultimate extinction. It was thought that inbreeding was attended by cumulative evil effects due to consanguinity. Unfortunately, at this time Mendel's experiments were unknown and these early workers were unable to give their observations a Mendelian interpretation.

About 1905, East and Shull, working independently, carefully observed the effects of inbreeding in maize. Among other things they found that the decrease in vigor due to selfing is greatest in the first selfed generation and continues only to a certain point, after which there appears to be no further decrease. Somewhat later East and Hayes concluded that loss in vigor is correlated with a decrease in heterozygosity. While the investigations of these early workers threw much light on the subject, the correct interpretation of the effects of inbreeding had not yet been obtained.

Further knowledge of inheritance, particularly that of the chromosome theory of heredity and linkage phenomena, together with the view that most normal characters are the result of the interaction of many genes, furnished a basis for the Mendelian interpretation of hybrid vigor, which was made by Jones. Jones worked with the same crop and observed the same phenomena that had been observed by previous investigators. In fact his experiments were a continuation of the early investigations of East on the effects of inbreeding. Jones concluded that heterosis is due to the complementary action of dominant linked growth factors and that theoretically it would be possible to combine all

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* Presented to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

†The writer wishes to express his appreciation to Dr. H. K. Hayes, Professor of Plant Breeding, for his valuable suggestions and assistance in planning the investigations, and in analyzing the data presented; he is also grateful for the privilege of using the data obtained during the years 1916 to 1923.

The rust reaction studies were carried on as a co-operative project between the sections of Plant Breeding and Plant Pathology. The writer wishes to express his appreciation to Dr. E. S. Stakman, Professor of Plant Pathology, for valuable suggestions.

The details of the rust studies made during the winter of 1925-26 were carried on by Mr. Gavril Proytchoff, a graduate student in plant breeding. Acknowledgement is due him for this assistance.

of these desirable factors in a homozygous condition and so obtain a strain that remained vigorous under conditions of self-fertilization. He draws attention to the fact, however, that due to the lack of complete dominance, linkage and the large number of factors involved, the production of such a strain is rather a remote possibility. In maize, selection in self-fertilized lines leads to the isolation of both desirable and undesirable lines. While, as yet, no inbred lines of maize have been produced that are as vigorous as open-pollinated plants from the same source, it appears possible that in some normally cross-pollinated crops very vigorous and otherwise desirable inbred lines may be obtained.

Further knowledge of the effects of inbreeding led to the development of a new mode of attack in breeding cross-pollinated plants, which is known as "selection within self-fertilized lines." The method consists of artificially inducing self-pollination of desirable- appearing plants, the selection in the following generations of the more desirable-appearing individuals and their subsequent self-pollination. This leads eventually to the production of partial or complete homozygosis. Desirable lines can be used either as material for the synthesis of a new variety, or, if sufficiently desirable, a particularly self-fertilized line may itself furnish the foundation for a new sort.

This method is now widely used in maize breeding and self-fertility studies with many of the other cross-fertilized crops have been recently undertaken. The results of these investigations are of much interest in that they throw considerable light on the effects of inbreeding with widely different kinds of crop plants. The results thus far obtained will be briefly reviewed before proceeding to a discussion of self-fertilization in timothy as a means of studying the inheritance of such important characters as seed production, vigor of growth and rust resistance, which constitutes the subject of the investigation reported in this paper.

Literature Review

The effects of self-fertilization were extensively studied by Darwin (3).* He believed that self fertilization was so injurious that plants dependent upon it must ultimately perish. However, he admitted that there were exceptions to this theory, as proved by the behavior of certain normally self-fertilized species. Darwin also concluded that the evil effects of inbreeding are cumulative and that the deterioration is more pronounced in the earlier than in the later selfed generations.

The method of breeding which involves controlled pollination and which is now being used extensively for the improvement of naturally cross-pollinated plants began with studies initiated independently by Shull (30) and East (5), about 1905, on the effects of inbreeding corn. Shull (30) calls attention to the fact that a field of corn contains many genotypes and that these can be isolated by inbreeding. Regarding the effects of inbreeding corn, Shull's conclusions may be re-stated as follows:

(1) The progeny of every self-fertilized plant is of inferior size, vigor, and productiveness as compared with the projeny of a normally cross-bred plant derived from the same source.

(2) The decrease in size and vigor is the greatest in the first selfed generation until a condition is reached in which there appears to be no further loss of vigor.

(3) Self-fertilized families from a common origin differ from one another in definite hereditary morphological characters.

(4) Regression of fluctuating characters has been observed to take place away from the common mean or average of the several families instead of towards it.

Shull also disproved the theory that the evil effects of inbreeding are due solely to accumulation of deleterious individual variations.

East and Hayes (6) self-pollinated over 30 strains of maize for from one to seven generations. Their results closely agree with those obtained by Shull. In every case there was a loss of vigor and the time of flowering was delayed. The decrease in vigor continued only to a certain point and was in no sense an actual degeneration. These investigators concluded that inbreeding in itself is

*Reference by number is to "Literature Cited," p. 435.

not injurious, but that both good and weak types are isolated, and that loss of vigor is correlated with a decrease of heterozygosity, The early investigators believed, apparently, that hybrid vigor was due to some physiological stimulous resulting from the state of hybridity itself. They also appreciated the fact that maize contained numerous undesirable recessive factors.

The explanation of the vigor of F_1 crosses and the loss of vigor in self-fertilized lines of normally cross-pollinated plants has more recently been placed on a definite Mendelian basis (7). The general acceptance of the Mendelian interpretation in cross-pollinated plants has led to extensive investigations in the field.

Jones and Mangelsdorf (22) self-pollinated a great number of lines of maize for five successive generations, and conclude that there is no single character which will serve as a criterion in the selection of selfed lines, which, on being crossed with each other, will produce high-yielding strains.

During the process of inbreeding, with the resulting segregation and recombination and approaching homozygosity, selection for particular factors is somewhat effective. By selecting tall plants as progenitors in each generation, tall strains can be produced. Disease resistance can be obtained, if resistance is inherited, by the selection and propagation of those plants which show no infection in fields where infection is present. Even with these characters the association is far from complete. Productiveness, yield of grain, shows no such simple relation. High-yielding strains may come from plants which are relatively poor producers, and promising strains during the first generations may be unproductive, or undesirable in some other respect when finally reduced to uniformity. Effective selection, therefore, must be based upon the progeny test after relative homozygosity is attained.

Hayes (11), with inbred strains of maize, sought to determine the relationship between many different characters and yielding ability by means of correlation coefficients. Yield of selfed strains was found to be strongly correlated with such characters as length of ear and number of ears index. Neither smut infection nor cob discoloration appeared to be markedly related to yielding ability. After making rather extensive computation, Hayes concludes that the only sure criterion of the value of any particular selfed line is the progeny test.

Previous to the work of Fergus (8), in 1921, red clover (*Trifolium pratense* L.) had been considered self-sterile. After making a rather extensive literature review Malte (27) concludes as follows: "In comparing the evidence available in the matter of fertilization of red clover, it is apparent that the evidence supporting the contention of self-fertility is very weak and under the circumstances it may be considered justified to conclude that red clover is normally, if not always, self-sterile."

In 1921 Fergus (8) self-pollinated 650 heads, each head representing a separate plant. From the 32 heads which were partially self-fertile, 153 seeds were secured. This gave an average of 4.8 seeds from each seed-producing head. In 1922 these 153 seeds were sown in pots in the greenhouse. Some of the seeds did not germinate, and many abnormalities appeared. About 80 plants developed normally. These were planted in the field and from 1 to 14 heads on each plant were self-pollinated. Of the 463 heads treated, 115 produced seed, averaging 9 seeds per head. Fergus concludes that self-fertile lines do exist in red clover and cites as evidence (1) the production of chlorophyll-deficient seedlings from self-fertilized seed; (2) the uniformity within an inbred family; (3) the high-yielding second generation plants from high-yielding parents; (4) the consistency in seed-yielding ability of some groups, and the inability of other groups to set seed under conditions of self-fertilization.

Kirk (24) obtained results very similiar to those of Fergus. Only 45 per cent. of the 430 heads treated produced seed, and ranged from almost complete self-sterility to a high degree of self- fertility. The most highly self-fertile heads yielded 48 seeds which was above the average production of open-pollinated plants. Kirk also emphasizes the loss of vigor due to self-fertilization and the uniformity within an inbred family.

Williams (33) obtained similiar results and concludes: (1) red clover is in the main self-sterile but some plants are to a small and varying extent self-fertile; (2) self-fertility is probably an inheritable character,

but owing to the hetorozygous condition of the parents, some of the progeny of self-fertile plants are fairly self-fertile while others are practically or entirely self-sterile.

Ulrich (31) studied the comparative self-fertility of different varieties of rye (*Secale cereale* L.) He concluded that there are individual differences within a race, both fully sterile and strongly self-fertile individuals being found.

Heribert-Nilsson (16) used three methods of isolation in self-pollinating rye, namely, (1) glass test tubes, (2) isolation by space, and (3) parchment bags. As an average of some 356 plants isolated, he finds the percentage seed setting to be about 1, 7, and 4 per cent, respectively, for the three methods. In general, there was found to be a decrease in vigor due to inbreeding, but after the fifth generation there appeared to be no further decrease. Some inbred strains were produced which continued vigorous and yielded more than the normal variety..

In 1926, Brewbaker (2) published the results of studies of self-fertilization in rye. The following table gives the relative average yields of selfed lines in each of fout generations. The yield reported in the fifth generation is an average for eight selected strains.

Relative Average Yields of Selfed Lines of Rye

Normal variety, cross-pollinated (12)	100.0%
1st year selfed lines (23)	74.9%
2nd year selfed lines (30)	63.5%
3rd year selfed lines (36)	56.2%
4th year selfed lines (26)	59.7%
5th year selfed lines (8 selected)	100.0%

From these data it is clear that a considerable reduction in vigor resulted from fertilization, and this was most marked in the first three generations of selfing. Certain strains appear outstanding in vigor and yielding ability and are equal to or better than the normal variety. The various strains differed widely in fertility, and many abnormalities were observed. Brewbaker concludes that selection in self-fertilized lines is the most effective and practical mode of attack in the improvemnt of rye.

N. Hjalmar Nilsson (29) began selection in sugar beets by controlled pollination at Svolof, Sweden, in 1914. The percentag of lines which bred true for morphologic characters, or which segregated only in or character after the first selfing, was abo 45. In general, there was a decrease i vigor in the inbred lines but a number c them yielded as high or higher than the be of the cross-bred varieties. Less than 5 pe cent. of the inbred strains showed signs c so-called degeneration. Fertility was plair ly inherited and strains which possessed th character had larger and better develope seeds.

Fruergaard (9) worked with selfed line of turnips. All of the inbred lines were le vigorous than the original varieties, the re duction in yielding ability on the averag was about 30 per cent. Rutabagas behave quite differently as only 2 out of 35 inbre lines were appreciably reduced in yield.

McRostie (28) and Hamilton (10) hav artificially self-pollinated sunflowers for si or seven years. Several morphologically di tinct types were produced and each of thes became very uniform after five generations o selfing. Most of the strains were much re duecd in vigor but several strains were ob tained which were as vigorous as the parenta stock.

Kirk(25) has compared selfed lines of al falfa with the parental lines from which the were obtained. In most cases inbreeding brought about decreased vigor, decreased fer tility, and a marked uniformity within eac inbred line. Some selfed lines were obtaine in both second and third selfed generation which were as vigorous as the plants fron cross-fertilized seed.

Jenkin (19) studied the effects of artifi cial self-pollination in rye grass (*Lolium per renne* L.) Promising plants were selectec from various populations. Many of thes plants were artificially cross-pollinated anc at the same time inflorescences on the sam plants were self-pollinated. Under condi tions of self-fertilization some plants wer highly self-sterile while others were rathe highly self-fertile. Plants were grown from both the cross-fertilized and the self-fertilizec seed and the yields compared. A markec reduction in vigor was observed in the inbrec lines. The plants grown from cross-fertil ized seed outyielded the inbred strains by from 37 to 224 per cent. While some of the

lines were more vigorous than others, none of them yielded as well as those grown from cross-fertilized seed.

Kearney (23) has artificially self-pollinated cotton for from five to seven generations. The inbred strains were not reduced in vigor, nor were they inferior to the open-pollinated stocks in any way. Self-pollination occurs normally in cotton to a much greater extent than cross-pollination. In such crops it should not be necessary to practice selection in artificially self-fertilized lines for many generations.

The improvement of timothy (*Phleum pratense* L.) wast started first by Hopkins of West Virginia in 1893. Hopkins selected several distinct types. These selections proved disappointing, however, when grown in other districts, indicating that breeding work in timothy may have to be done locally.

Timothy breeding was started at Cornell, and also at University Farm, in Minnesota, in 1903, and at Svalöf, Sweden, in 1905 (34).

Because of the extent of the Cornell breeding investigations, it appears desirable to review them here in some detail. The work at Cornell was started first by Professor T. F. Hunt and was taken over by Webber (32), in 1907. In 1903, 223 samples of seed were secured, 163 of which were from different parts of the United States, and the other 60 from foreign countries. Forty-two plants of each lot were grown, making 9,366 plants in all. Every third plant was a check, grown from commercial seed.

In 1905, 147 plants were selected as representing extremes of certain characters. Open-fertilized seed was saved from these and 42 plants were grown from the seed of each parent plant. These plants, grown from open-fertilized seed, gave little indication of a transmission of the characters for which the plants had been selected and therefore the following procedure was adopted.

(1) Desirable-appearing plants were selected on the basis of many plant characters such as habit of growth, leafiness, vigor, and rust resistance. These were propagated by means of bulblets (clonal propagation) and by the use of self-fertized seed. The comparative vigor of the clonal lines was studied, as well as the uniformity of breeding habit of the progeny produced from self-fertilized seed. This led to the selection of certain clonal lines which appeared most desirable and which were known to produce rather uniform progeny under conditions of self-fertilization.

(2) Two methods were then used to reproduce the desirable lines: (a) Desirable-appearing plants were self-fertilized and the seed obtained was used to start an isolated plot where seed was saved under normal pollination conditions. (b) Clones were used to start plants which were placed in isolated plots. These methods, in general, involved the use of only a single generation of self-pollination in the production of new varieties.

Webber apparently thought that vigor might be regained if open-fertilization within the type was allowed. In 1908-1909, 24 seedlings from each of 100 types were grown from self-fertilized seed. While a few of these lines proved to be very heterozygous, many of them rather uniformly transmitted the characters for which they had been selected. These new strains were tested in the field and of the 17 new types that were eventually chosen, 3 yielded less than the checks and 14 yielded more. In 1910 the new types outyielded the checks by an average of 851 pounds per acre, while in 1911 an increased yield of 3,062 pounds per acre was obtained. The great increase in 1911 was due largely to the fact that there was a rust epidemic and as rust resistance was one of the characters for which the new types had been selected they naturally far outyielded the checks.

The work at Cornell, then, proves that improved varieties of timothy can be obtained.

To what extent self-fertilization leads to a reduction in vigor, or how many generations of self-fertilization should be continued was not determined.

The method of breeding timothy at Svalöf, as reported by Witte (34), does not differ essentially from that practiced at Cornell. Two improved lines, Svalöf's Gloria and Svalöf's Primus, that were distributed from the Svalöf's station, both out-yielded ordinary timothy.

In 1919, Hayes and Stakman (15) made a preliminary report on the selection in timothy for rust resistance and other important economic characters. Eleven of the better Cor-

nell selections and 6 of the better Minnesota selections were used. One hundred and twenty-five plants of each selection were started in the greenhouse and transplanted to the field. Correlated data were taken on such important characters as yield, erectness, average length of head, height, number of stools, and rust resistence. All of the above data, except those on rust, were taken on the first growth the latter part of June. Rust spores were collected and the second growth of the timothy plants was sprayed with a spore suspension. The Cornell selections showed a high percentage of resistant plants, while the Minnesota selections were largely susceptible. Most of the plants winter-killed during the severe winter of 1917-18. The following year open-fertilized seed was saved from some plants which escaped winter-killing for a continuation of the study. It was decided to study selection in self-fertilized lines as a method of breeding better strains of timothy.

In 1922, Hayes and Barker (12) reported studies on self-fertilization in timothy. Twenty-five bulblets were taken from each of several individual plants and isolated, some in the field and others in the greenhouse. There was a marked similiarity in the percentage of seeds obtained from an isolated clonal line in the greenhouse and from the same in an isolated field plot. Some lines proved to be highly self-sterile and others highly fertile. They found albino seedlings in five out of the twelve lines worked with and concluded that self-fertilization in timothy is a logical means of freeing a commercial variety from undesirable recessive characters.

Prior to the present studies, Barker and Hayes (1) studied the reaction of timothy seedlings to stem rust, *Puccinia graminis phlei pratensis* (E. and H.) Stak. and Piem., under greenhouse conditions. The results indicated that resistance to rust was a dominant character and that resistance or susceptibility was dependent on a single genetic factor pair. The progeny of resistant plants were used as the foundation for the studies here reported.

In 1925, Hayes and Clarke (14) made a preliminary report of some phases of the studies of the effects of self-fertilization in timothy. They concluded: (1) Self-fertilization in timothy does not lead to as grea reduction in vigor as has been observed i maize, for some inbred lines outyielded th average for the commercial variety. (2 Rust-resistant lines of timothy can be ob tained through selection within self-ferti ized lines. (3) Seed-setting under condition of self-pollination is probably due to genet causes.

Materials, Methods and Conditions of the Study

Because the present study is a continu tion of the Minnesota project, it appears d sirable to present the previous work in som detail, although the more important resul of these studies have been referred to in th literature review.

In 1916, a project for timothy selectio was outlined at the Minnesota station. Th foundation stock consisted of eleven of th better Cornell sorts and six of the bett Minnesota selections. Seedlings were star ed in the greenhouse and approximately 12 plants of each selection were placed in th field in rows four feet apart, the plants bein placed three feet apart in the row. In 191 correlated data were taken on such characte as yield, erectness, average length of hea height, number of stools, and rust resistan (15). During the winter of 1917-18, near all the plants winter-killed. In 1918, se was saved from some of the plants that su vived the severe winter. This seed was sow in the greenhouse and the plants transplant to the field in the spring of 1919. Not were taken during the summer of 1919. Som of the plants were susceptible to rust, wh others were resistant. In the fall of 191 bulblets were taken from five rust-resista plants and planted in isolated plots and i creased during 1920-21. Other bulblets we taken to the greenhouse for selfing and som plants of the same clonal lines were self in the field. Some crossing was done al between different clonal lines. In the spri of 1922, seed from the following sources w sown in the greenhouse in pots:

1. Seed produced by rust-resistant pla in clonally reproduced isolated plo
2. Seed from clonal lines that had be selfed in the greenhouse and field.
3. Seed from crosses between clonal lin
4. Commercial seed.

Before the seedling plants were set out in the field they were inoculated with stem rust and the susceptible plants became heavily infected. Within each progeny line the resistant and susceptible plants were placed into different groups and transplanted to the field in separate cultures. Thus, each line was represented by separate progenies, the one consisting of resistant plants and the other of susceptible ones.

During 1923, data were taken and the yield determined. Forty-one rust-resistant plants were self-pollinated. Thus, at the beginning of 1924 the following seed material was available:

1. Commercial seed from Northup King Sterling.
2. 1-year selfed seed from Northup King Sterling.
3. 1-year selfed seed from increase plots.
4. 1-year selfed seed from crossed clonal lines.
5. 2-year selfed seed from clonal lines.

This material was used in a continuation of the study during the years 1924 to 1926, inclusive. The nature of the seed used, and the number of lines planted in each of these three years is presented in table I.

In 1924, each inbred line consisted of 10 plants in the yield series and from 1 to 22 (usually 22) plants in the selfing series. In 1925 and 1926, each inbred line consisted of from 1 to 20 (usually 15 to 20) plants.

Practically the same methods were followed during each of the three years 1924 to 1926, inclusive. In general, self-fertilized seed was obtained from plants of desirable-appearing lines. In 1925, some of the lines grown were the progeny of relatively high seed-producing plants selfed in 1924, while others were from low seed producers. For the 1926 planting seeds were used from plants selected on the basis of rust reaction. The seed was sown in three and one-half inch pots in the greenhouse during the early part of February. In some cases the plants were clipped to prevent them from heading out before the time for planting in the field. Data were taken on the plants as they grew in the greenhouse.

During the latter part of April, the plants were transplanted to the field, being placed in rows three feet apart, with the plants one-half feet apart in the row. In 1924, two series were planted, one as a yield test and the other for selfing. In the yield series each fifth row was from commercial seed as a check. In each of the years 1925 and 1926, all of the plants were placed in a single series, some of the plants in each line being selfed and others harvested as a yield trial.

During the summer, data were taken on such characters as date of flowering, vigor, uniformity of type, height, uniformity of height, erectness, leafiness, number of culms, coarseness of culms, height of leaves on culms, and length of spike.

The seasons of 1924 and 1925 were very favorable, there being sufficient warmth and moisture for the normal development of the plants. While there was a fair amount of wind, there were no very severe storms during the time the plants were in bloom. The summer of 1926, however, was a very unfavorable one for timothy. A long dry period during May and June prevented the plants from getting a good start. Although the plots were artificially watered, the plants failed to make much growth. In certain lines none of the plants reached the flowering stage, and some of them failed to survive the period of drought.

In the field tests, in 1924, hay was harvested from the plants started that year and also from those that were planted out in the spring

TABLE 1

Nature of the seed used and the number of lines planted in each of the years 1924-26, inclusive.

Nature of Seed	Number of Lines Planted 1924	1925	1926
Commercial	14 (200 plts)	3 (150 plts)	2 (104 plts)
1 year selfed	20	24	11
2 years selfed	21	40	35
3 years selfed	—	41	33
4 years selfed	—	—	29

of 1922. In 1925, plants were harvested from the lines started that year and also from those started in 1924. On account of the poor growth conditions during the summer of 1926, no yield test was taken from the plants started that year. Plants were harvested, however from all of the lines started in the spring of 1925. Each year, all of the plants were harvested on the same day; during the latter part of July. The hay from each line was placed in a separate sack, carefully weighed and then stored in a dry place for about three weeks. It was then oven-dried and weighed again, and the moisture-free weight calculated per single plant in grams. The shrinkage was also calculated on a ten-plant basis.

During each of the three years, several desirable-appearing plants in each line were selfed, except in 1926, when approximately 20 per cent. of the lines could not be used because the plants did not reach the flowering stage. Practically all of the selfing was done during the last week of June and the first week of July. A stake was driven beside each of the selected plants, and a few days before the spikes started to bloom, several spikes, from 2 or 3 to 12 or 15, were gathered together and a bag placed over them. The bag was then tied firmly, but not too tightly, about the group of culms and then tied to the stake. After the spikes had started to flower the bags were watched closely to see that they were properly adjusted to suit the growth of the plant, and, if a bag showed any signs of breaking, another was placed over it. When ripe, the spikes were harvested, those from each plant being placed in a separate envelope. The envelopes were packed in a box and kept in a dry place for a few weeks. The spikes were then threshed out by hand and the seeds counted.

The number of seeds produced by each plant was divided by the number of spikes selfed on that plant; this gave the average seed-production per spike for each individual plant. The averages of all the plants in each line were then totalled and divided by the number of plants in the line; thus the average seed-production per spike for each line was obtained.

In 1924, the spikes were placed in twelve-pound Kraft paper bags; these were fairly satisfactory in dry weather but when wet they were easily torn by the wind. In 192 26, vegetable parchment bags glued with casein waterproof glue were used. Thes bags were found to be very durable, and the also admit more light.

During the summer of 1925, there was severe stem-rust epidemic throughout the en tire timothy field. Some plants were ver susceptible while others were highly resi tant. A careful inspection was made of eac individual plant, both in the inbred lines an in those grown from open-pollinated comme cial seed. The plants were placed in fiv classes on the basis of their rust reaction.

0—No rust.
1—Small pustules; resistent.
2—Pustules larger than in 1 but not ver large, little coalescence of pustules possible resistant.
3—Coalescence of pustules common; su ceptible.
4—Very badly rusted.

A project was then outlined for the dete mination of the rust reaction of the progen of some of these plants under greenhouse con ditions. The details of this project were ca ried on by Mr. Gavril Proytchoff, a grad uate student in plant breeding. The seed o the lines selected for study in the green house was sown in wooden flats, on the 10th 11th, and 12th of October, 1925. The fla were filled with a mixture of three parts goo soil to one part of sand. Each grain wa planted separately about one-fourth of a inch deep, and about one and one-half inche apart each way. In all, ninety-five hundre grains were planted and these represented th progeny of 133 self-fertilized parent plant Some of the seeds did not germinate, and number of chlorophyll deficient seedling were produced. There remained 6,275 wel developed plants avaidable for the study.

Several badly rusted plants were take from the timothy field in the fall and grow in the greenhouses to supply spores for in oculation purposes. Several methods of in oculation were used and the seedlings trea ed were from four weeks to three months old The first inoculation was made on Decembe 11th, the plants being moistened thoroughly and then sprayed with urediniospores. Du ing the first ten days a relatively high tem perature was maintained and the atmo

phere was kept moist by spraying water on the steam pipes.

On December 22nd, a second inoculation was made, in the same way as the first one. The results were unsatisfactory, the infection being feeble and not uniform. Therefore, another method of inoculation was tried. The plants in the flats were thoroughly moistened and then brushed over with heavily rusted timothy plants which had been grown in small pots. The flats containing the seedlings were then placed in a moist chamber containing a small amount of water, and kept there for 48 hours. The results were very satisfactory and, in some cases, the infection was as high as 100 per cent. On account of the limited space in the moist chamber, all of the lines could not be treated at the same time, and all of the plants could not be inoculated at the same stage of development. The "cloth" method was used also with good results. After being thoroughly moistened, the plants in the flats were inoculated by "brushing" with heavily rusted timothy plants. The flats were then covered with moistened cloths. In order to keep the cloths moist it was found necessary to sprinkle them at least twice each day and keep them covered with paper.

The inoculated plants were examined usually from 17 to 23 days after being treated. Sometimes, owing to cloudy weather, the rust development was slow and examination was made after a longer period. In order to indicate the degree of infection the following symbols were used:

0. IMMUNE. No development of uredinia.
1. VERY RESISTANT. The plants of this class are characterized by the presence of minute and isolated uredinia.
2. MODERATELY RESISTANT. In the plants of this class one notices isolated uredinia of small to medium size; hypersensitive areas in the form of necrotic circles; pustules often in green but slightly chlorotic islands. In some doubtful cases a number of plants of class 2 were reinoculated.
3. SUSCEPTIBLE. The plants of this class are infected with large uredinia, and susceptibility to rust is quite evident.
4. VERY SUSCEPTIBLE. The presence of numerous large and confluent uredinia is characteristic of this class; true hypersensitiveness is entirely absent.

All of the plants studied were thus classified and the results tabulated. The rust reaction of each line was determined by the behaviour of the individual plants within the line, the following symbols being used:

H—Heterozygous; segregating with more plants in class 0 and 1 than in 3.
R—Resistant; no plants of class 3.
R?—Resistant; less than 30 plants in the trial or slightly more but not repeated.
S—Susceptible; the plants mostly of class 3.
S?—Susceptible; several plants of class 1; mostly of class 3.

The rust reaction of the progenitors of these greenhouse lines, as well as that of the field lines they represented, had been previously determined. A correlated study was then made of the reaction of the selfed lines in the field, of the individual parent plants in the field, and of the progeny lines grown in the greenhouse, in order to determine whether or not there was a significant correlation between the rust reaction in the field and in the greenhouse. In segregating lines the ratio between resistant and susceptable plants was calculated.

The primary purpose of the study was to determine the effects of selfing on such characters as seed production, vigor uniformity, and disease resistance. The methods used in obtaining the data have already been outlined. In order to get a clear conception of the degree of fertility, under conditions of self-pollination, certain class centers were used and the distribution of the individual plants within these cultures was studied for each selfed generation grown. The mean seed-production for each generation in each year was calculated and the average production in open-pollinated plants also was determined. The yields obtained from the different lines were treated in much the same manner, the yielding ability of the inbred lines being compared with that of the commercial checks.

The inheritance of such characters as seed-production and yielding ability was studied by means of correlation coefficients. The seed production of each parent plant and also the mean production of each line was studied in relation to the production of each of the progeny individuals and of each progeny line in succeeding selfed generations. Correlation coefficients were obtained and in this way an

effort was made to determine whether or not, under conditions of self-pollination, fertility is inherited, and to what extent homogeneity in seed-production is obtained by continuous inbreeding. In the study of inheritance of yielding ability, correlation coefficients were obtained to determine the degree of inheritance of the character in successive selfed generations. Interrelationships of the various characters were studied to determine whether there was genetic or physiological correlation between the important characters such as vigor or plant, rust reaction, and seed-production, under conditions of self-fertilization.

EXPERIMENTAL RESULTS

Chlorophyll Deficiencies

The occurrence of chlorophyll-deficient seedlings in self-fertilized lines of timothy is of interest in view of the fact that they have been found so frequently in other normally cross-pollinated crops. Hutchinson (18) reports chlorophyll-deficient seedlings in 530 out of 1872 families of maize, grown from first-generation self-fertilized seed. He also states that most of the variations in maize are simple recessives, the factors concerned being scattered well throughout the entire chromosome complex. Hayes and Brewbaker (13) tested first-year selfed lines of 6 varieties of maize commonly grown in Minnesota. They report that the per cent. of strains producing chlorophyll-deficient seedlings varied from 39.4 per cent. in the variety Minnesota No. 13 to 7 per cent in Northwestern Dent. Lindstrom (26), Jones (21), and other investigators have reported chlorophyll deficiencies and other abnormalties in maize.

Fergus (8) and Kirk (24) have each reported chlorophyll-deficient seedlings in red clover. Kirk observed these abnormalities in 21 out of 81 self-fertilized lines. Most of the chlorophyll-deficient plants were albinos which never developed beyond the seed leaf stage. Brewbaker (2) reports chlorophyll deficiencies in 23 out of a total of 31 inbred strains of rye which were continuously selfed for four generations. Twelve of these strains segregated in the first selfed generation and after that appeared normal. He concludes that each of three types of chlorophyll deficiencies, which were carefully analyzed, was a simple recessive to the normal condition. Hays and Barker (12) report the occurence of white seedlings in 5 out of 12 first-generation selfed lines of timothy.

In the present studies, chlorophyll-deficient seedlings were observed in 1924 but no record was kept. During the years 1925-27, however, the seedlings in the greenhouse were carefully inspected and accurate data obtained. The number of inbred lines grown in each of the three years, together with the number of seedlings in each line and the percentage of lines containing chlorophyll deficiencies, are presented in table II.

TABLE II.

Percentage of inbred lines of timothy exhibiting chlorophyll deficiencies.

Year	Number of inbred lines	Number of Seedlings per line		Percentage of lines containing chlorophyll deficiencies
		Range	Average	
1925	105	4 to 40	30	37.1
1926	108	10 to 90	50	19.4
1927	41	12 to 49	40	17.0

The particular line that exhibited chlorophyll deficiences, together with the original source of the material, the selfed generation, the number of sedlings grown, and the chlorophyll deficiences observed, are presented in table III.

The results presented in table II appear to indicate that under conditions of continued self-fertilization the percentage of clorophyll-deficient types tends to be decreased.

Chlorophyll deficiencies, as a rule, appear to be recessive and plants possessing these deleterious characters are either lethal or greatly reduced in vigor. An investigation reported by Heribert-Nilsson (17) serves to demonstrate how these weak types tend to be eliminated from normally cross-pollinated crops. This investigator observed a bloom-free character in rye which proved to be a simple recessive. He crossed plants exhibiting character with normal plants. The progeny was grown in bulk on an isolated plot for six generations, the bloom-free plants being removed each year before flowering. He notices that the number of abnormal plants decreased from year to year and his results fit well the following formulae:—

N^2—1 : 1 phenotypic ratio
n : 1 gametic ratio

when n equals the filial generation following the cross, and the first and last terms of the ratio represent normal and bloom-free plants and gametes, respectively. Thus in the F_6 generation the phenotypic ratio would be 35:1 and the gametic ratio 6:1. This indicates a rather rapid elimination of the bloom-free type.

The occurence of white seedlings is of particular interest in view of the fact that they comprise slightly over 70 per cent. of all the chlorophyll deficiencies here reported. Table IV presents the ratios of normal green seedlings to albinos. The actual number of green and white plants observed in each line is given, and these are grouped according to the Mendelian ratio they most nearly approach. In this grouping it is appreciated that an error may be made, for a line segregating for three factors in one selfed generation would be expected to segregate for less than this number in later generations. It will be noticed that there are 25 lines in all. These represent so many lines of direct descent, some of which extend through two or three selfed generations. The numbers given in table IV were obtained by summating the green seedlings and albinos, respectively, starting with the last generation in which segregation occurred and following the direct

TABLE III.

Number of normal and seedling chlorophyll deficiences in those lines of timothy which produced chlorophyll-deficient types (1925 to 1927)

Original source	1st Selfed Generation				2nd Selfed Generation				3rd Selfed Generation				4th Selfed Generation				5th Selfed Generation			
	Gr	Wh	Y	V	Gr	Wh	Y	V	Gr	Wh	Y	V	Gr	Wh	Y	V	Gr	Wh	Y	V
Northrup King	32	3	4	–	41	–	–	–												
Sterling	16	1	–	–																
	25	–	–	2	31	–	4	–												
	11	1	–	–																
	28	2	–	–																
	35	–	–	–	54	5	–	–	44	1	–	–								
					55	1	–	–	36	1	–	–								
	30	–	–	–	27	1	–	–												
					25	5	–	–	51	9	–	–	47	–	–	–				
	*				8	2	3	–												
Cornell 1777	*								35	–	–	–	13	1	–	–				
	*				*				35	–	–	–	26	2	–	–				
	*				*				40	–	–	–	43	1	–	–	25	–	–	–
	*				*								59	–	–	–	28	1	–	–
	*				*				38	–	–	–	126	2	–	–				
	*				*				37	1	–	–								
	*				*				19	5	–	-								
	*				*				12	1	–	–								
Cornell 1620	40	–	–	–	39	–	–	1	33	–	–	–								
					28	1	–	–												
	40	–	–	–	44	4	2	1	20	–	–	–	40	–	–	–				
	*				22	2	–	–												
	*				17	2	–	–	42	1	–	–	28	–	–	–				
	*				35	–	–	–												
Univ. Farm Sel.	*				35	–	–	–	34	–	–	1	44	–	–	–				
Cornell 1635	*				40	–	–	–	112	1	–	–								
Cornell 3230	*								40	–	–	–	101	2	1	–				
Cornell Cross	*				40	–	–	–	122	1	–	–								

*No data were available concerning the behaviour of the progenitors of these lines in these selfed generations.

line of descent back to the first selfed generation recorded in table III. In using this method care was taken to see that different generations of a line were not added together if they were widely different in their type of segregation. All that was hoped for was an approximation which would give an idea of the relative complexity of the result. The method tends to correct errors that are due to the small numbers used and gives a better representation of the behavior of each line than would a consideration of each generation by itself. It can be seen from table IV that in three of the lines the ratio of normal green seedlings to albinos approaches the Mendelian ratio of 3:1. In 11 lines the ratio varies from 8.5:1 to 30.5:1, all of these probably falling within the 15:1 ratio group. In the remaining 11 lines the ratio varies from 45.5:1 to 162:1, thus coming within the limits of the Mendelian ratio of 63:1. Certain lines fitted almost equally well in either one of two different Mendelian ratios, their location being determined on the basis of their probable errors.

TABLE IV

Ratios of normal green to white seedlings, obtained in inbred lines of timothy.

ACTUAL NUMBERS OBSERVED Mendelian Ratios Approximated					
3 : 1		15 : 1		63 : 1	
Green	White	Green	White	Green	White
19	5	17	2	91	2
8	2	32	3	48	1
76	14	22	2	57	1
		11	1	68	1,
		12	1	141	2
		28	2	77	1
		16	1	164	2
		18	1	83	1
		84	4	127	1
		133	6	152	1
		61	2	162	1

In the interpretation of these results one must remember that only a relatively small number of seedlings were grown from each parent plant, and that only one or two of these were carried into the next generation. The small numbers, no doubt, account for some of the irregularities appearing in table III. For instance, it will be noticed that in several cases a generation in which segregation occurrer was proceded by one in which all of the seedlings were of a normal green color. In one case, the ratio of green seedlings to albinos in the second selfed generation approached a 15:1 ratio, while in the succeeding generation the results indicated a 63:1 ratio. When the numbers for the two generations are added the result approximates the Mendelian ratio of 15:1. After making allowance for the smallness of the numbers involved, however, the results would seem to indicate that the lack of chlorophyll development in white seedlings in timothy may be explained by the interaction of at least three complementary recessive factors which are independently inherited. All of these must be present in a homozygous condition for the production of a white seedling. When all three pairs are heterozygous, ratios of 63.1 would be obtained in the progeny.. If one was a homozygous recessive and two pairs were heterozygous, 15:1 ratios would be expected in the progeny. The dominant allelomorphs of these recessives may be regarded as duplicate factors for chlorophyll development. On the basis of the chromosome theory of heredity three different loci must contain, therefore, duplicate factors for chlorophyll development, any one of which leads to the production of normal chlorophyll.

It is possible to explain the results obtained for any particular line by linked factors for chlorophyll development. If the factors are closely linked in such a manner that a dominant factor for one allelomorphic pair is carried in the same chromosome as a recessive for another pair, and if a double recessive must be obtained to produce white seedlings, such will occur as a result of the mating of two crossover gametes both containing both recessive factors. Such an explanation has been used in maize and the location of the factors in one chromosome has been proved (4).

Reaction to Puccinia graminis phlei pratensis (E. and H.) Stak. and Piem.

According to Johnston (20) timothy rust was first reported in the United States in 1882. Since that time the disease has become wide-spread and a number of severe epidemics have been reported. In 1907, Webber (32) observed a severe infection of rust in

his experimental plats at Cornell and states that rust is the most serious disease affecting timothy. He also noticed a great variation among plants in their susceptibility to rust, and in the selection of desirable-appearing types he paid close attention to their rust reaction. Hayes and Stakman (15) and Barker and Hayes (1) studied the reaction of timothy to stem rust. The results of their investigations indicate: (1) that resistance to rust is a dominant character and that a single factor pair is involved; and (2) that no evidence was obtained of more than a single physiologic form of timothy rust.

The present study was begun in the summer of 1925, when a severe rust epidemic prevailed throughout the experimental timothy nursery. Some of the plants were badly rusted, while on others, not far distant, practically no uredinia whatever could be found. The individual plants were carefully inspected and classified as follows:

0—No rust.
1—Small pustules, resistant.
2—Pustules larger than in Class 1, but not very large, and not confluent; probably resistant.
3—Pustules numerous, large and often confluent; susceptible.
4—Very badly rusted.

Of the 105 inbred lines, 65 appeared to be segregating for reaction to rust as each of these lines contained both resistant and susceptible plants. Thirty-five lines appeared to be homozygous for resistance, although they contained a few plants of class 2. In the remaining five lines every plant was badly rusted, indicating homozygosity for susceptibility.

It must be remembered, however that none of these lines contained over 20 plants, while a few of them consisted of only 4 or 5 individuals. It was observed also that about 90 per cent. of the plants, grown from open-fertilized commercial seed, were badly rusted.

In a continuation of this study, under controlled conditions in the greenhouse, progenies were grown of 133 parent plants, and these represented 55 of the lines grown in 1925. The classification of each of the lines for rust reaction in the field and greenhouse is given in table V. The symbols used in the classification of the selfed lines, on the basis of the rust reaction of individual plants in the greenhouse, are are follows:

H—Heterozygous; segregating with more plants in class O and 1 than 3.
R—Resistant; no plants of class 3.
R?—Resistant; less than 30 plants in the trial or slightly more but not repeated.
S—Susceptible; the plants mostly of class 3.
S?—Susceptible; several plants of class 1, mostly of class 3.

In the majority of cases there is a marked correlation between the rust reaction in the field and in the greenhouse, as indicated by the reaction of the selfed lines in the field, of the individual parent plants in the field, and of the greenhouse lines. With few exceptions, the plants designated in the field as susceptible in the greenhouse, and most of susceptible produced progeny which were the plants which were resistant in the field produced progeny which bred true for re--sistance, or segregated for rust reaction under more severe conditions of rust infection in the greenhouse. There were a few exceptions, The greenhouse cultures 44, 51 and 133 bred true for susceptibility in the greenhouse although the parent plants in the field had each been placed in class 1.

In order to obtain a general idea of the nature and meaning of the results and their meaning, a summary table has been prepared (see table VI). In this table the various selfed lines are classified according to the number of years of self-fertilization, the field infection of the parent plants, and the nature of the rust reaction of the progeny in the greenhouse.

Of the 133 lines studied, 61 were heterozygous, with resistance dominant; 29 were resistant; 10 were susceptible; while 8 consisted mainly of susceptible plants, with a few resistant; and 25 consisted of resistant plants but the numbers were too small to be sure that the lines were homozygous.

In the main these results corroborate those of Barker and Hayes and indicate a single main genetic factor which differentiates resistance and susceptibility. However, there is some evidence of modifying factors which influence the effect of the main factor. Some resistant lines are more highly resistant than others. As an example, greenhouse culture 101 appears extremely resistant. The re-

TABLE V.

Classification for rust reaction in field and greenhouse (After Proytchoff.)

No. years selfed of field line	Field classification on individual plant basis: Parental line 0	1	2	3	4	Parent plant	Green house No.	Class for rust reaction of line in greenhouse
0		14	23	62		1	1	H
0		"	"	"		1	2	H
0		"	"	"		1	3	R?
0		"	"	"		2	4	S?
0		"	"	"		2	5	R?
0		"	"	"		1	6	H
0		"	"	"		2	7	H
0		"	"	"		1	8	R?
0		"	"	"		1	9	H
0		"	"	"		4	10	S
1		15	2	3		1	11	H
1		"	"	"		1	12	R
1		"	"	"		1	13	H
1		19		1		0	14	R?
1		"		"		0	15	R?
1		13	6	1		2	16	H
1		"	"	"		2	17	R
1		17	2	1		1	18	H
1		"	"	"		1	19	H
1		"	"	"		1	20	S?
1		"	"	"		1	21	H
1		15	2	3		1	22	H
1		"	"	"		1	23	R?
1		14	5	1		2	24	R?
1		"	"	"		2	25	R
1		"	"	"		2	26	R?
1		10	4	6		1	27	H
1		"	"	"		1	28	R?
2		9	7	1		1	29	R
2		"	"	"		1	30	R?
2		"	"	"		1	31	R?
2		12	5	3		1	32	R?
2		"	"	"		4	33	S
2		"	"	"		1	34	R
1		8	8	4		1	35	H
1		"	"	"		2	36	R?
1		15	4	1		1	37	S?
1		"	"	"		2	38	R
1		18	2			1	39	H
1		"	"			1	40	H
1		"	"			1	41	R
1		"	"			0	42	H
1		"	"			0	43	H

No. years selfed of field line	Field classification on individual plant basis: Parental line 0	1	2	3	4	Parent plant	Green house No.	Class for rust reaction of line in greenhouse
1		18	2			2	45	H
1		16	2	2		1	46	R
1		"	"	"		1	47	H
1		"	"	"		2	48	R?
2		16	4			0	49	H
2		"	"			1	50	R
2		"	"			1	51	S
1		18	2			0	52	H
2		5	3	12		2	53	R?
2		19	1			1	54	H
2		5	3	12		1	55	R
2		19		1		0	56	R
2		10	3	7		0	57	H
1		3	8	9		1	58	R
1		"	"	"		1	59	H
2		19	1			0	60	H
2		15	2	2		1	61	H
2		"	"	"		0	62	H
2		"	"	"		0	63	R?
2		9	6	4		1	64	H
2		"	"	"		1	65	R
2		"	"	"		1	66	R
2		"	"	"		4	67	S
3		10	7	3		2	68	R?
3		"	"	"		1	69	H
3		7	6	7		2	70	R?
3		7	7	6		1	71	H
3		"	"	"		1	72	R?
3		"	"	"		1	73	R
3		"	"	"		1	74	H
3		"	"	"		1	75	H
3		12	4	4		1	76	H
3		"	"	"		1	77	H
3		"	"	"		1	78	R
3		"	"	"		1	79	H
2		16	3	1		0	80	H
2		"	"	"		0	81	H
2		"	"	"		1	82	H
3		1	5	14		3	83	S
3		"	"	"		4	84	S
3		13	2	5		4	85	S
3		"	"	"		1	86	H
3		"	"	"		0	87	H

No. years selfed of field line	Field classification on individual plant basis: Parental line 0	1	2	3	4	Parent plant	Green house No.	Class for rust reaction of line in greenhouse
3			2	9		4	90	H
3			"	"		2	91	S
2		14	3	1		1	92	R
2		"	"	"		1	93	R
2		"	"	"		1	94	R
2		7	8	15		1	95	R
2		"	"	"		3	96	H
2		17	1	2		0	97	R
3		1	8	10		1	98	H
3		"	"	"		2	99	H
3		"	"	"		4	100	H
3		16	2			1	101	R
3		14				0	102	H
3		10	1	6		1	103	H
3		"	"	"		1	104	H
3		13		4		0	105	H
3		"		"		0	106	R?
3		9	5			1	107	H
3		"	"			0	108	H
3		"	"			0	109	R
3		11	1	2		1	110	R
3		1	2	9		1	111	H
3		"	"	"		4	112	S?
3		6	2	2		2	113	S?
3		6	3	8		1	114	R
3		"	"	"		0	115	R?
3		2	2	8		3	116	H
3		"	"	"		1	117	H
3		19		1		0	118	H
3		"		"		0	119	R
3		"		"		1	120	R
3		15	1			1	121	H
3		"	"			1	122	R?
2		10	3	5		0	123	H
2		12	2	4		0	124	H
2		"	"	"		0	125	R?
2		11		1		0	126	R?
2		"		"		1	127	R
2		13	1	2		0	128	H
2		"	"	"		0	129	H
2		"	"	"		0	130	R
2		"	"	"		2	131	S?
2		12		1		1	132	R?

action of 80 plants of this line was studied and inoculation was repeated on the plants which were uninfected in the first trial. Only 4 plants were obtained which were infected, and these were classed in the resistant group designated as No. 1, while all the other plants produced no uredinia. Similiarly, some susceptible lines are more susceptible than others.

TABLE VI.

Summary classification of rust reaction of selfed lines in the greenhouse in relation to field reaction of parent plant.

(After Proytchoff)

No years selfed of greenhouse line	Field infection of parent plant	Classification of lines on basis of rust reaction in greenhouse H	R	R?	S?	S	Total
1	0						0
1	1	4		2			6
1	2	1		1	1		3
1	3						0
1	4					1	1
2	0	1		2			3
2	1	15	5	3	2	1	26
2	2	1	2	3			6
2	3						0
2	4						0
3	0	10	3	3			16
3	1	4	11	4		2	21
3	2			1	1		2
3	3	1					1
3	4					2	2
4	0	5	2	2			9
4	1	15	6	2	1		24
4	2	1		2	1	1	5
4	3	1			1	1	3
4	4	2			1	2	5
Total lines							133

Seed Production under Conditions of Self-Fertilization

Selection within self-fertilized lines as a means of crop improvement can be used only for those crop plants which are more or less self-fertile. Seed-setting has recently been obtained, by means of artificial self-pollination, in several groups of plants which were formerly thought to be self-sterile. Most of the early investigators regarded red clover as self-sterile (27) and as late as 1925, Williams (33), in reporting "Studies concerning the red clover", states that "owing to the very small amount of seed produced it is doubtful if self-pollination can be regarded as a practical stepping-stone to the breeding of red clover." Kirk (24), however, with the same crop, observed a relatively high degree of self-fertility in a few of the plants which had been artificially self-pollinated.

Notwithstanding the fact that sunflowers were considered to be self-sterile, Hamilton (10), in 1920, bagged a large number of heads and obtained a seed-setting of from 15 per cent to 50 per cent. of that obtained from open-pollinated plants of the same sort. Brewbaker (2) in "Studies of self-fertilization in rye", found that the majority of the plants worked with were rather highly self sterile. In 1925, for all strains selfed 1, 2, 3, 4 and 5 years, he obtained a mean per centage seed-setting of 3.1, 4.7, 9.1,, 14.1 and 7.7, respecively. He observed some plants, however, that were rather highly self-fertile, and obtained a few strains that appeared to be more or less uniform for this character. Brewbaker states that the high degree of self-fertily in rye is not a serious handicap to the breeder, as by making sufficient isolations, enough seed of practically all lines can be obtained to continue the strains year after year.

In timothy, several investigators have obtained selfed seed by means of the isolation of spikes by covering them with paper or parchment bags and also by the clonal propagation of individual plants in isolated plots. The present investigation was undertaken, in part for the purpose of gaining additional knowledge concering the degree to which timothy is self-fertile, and to what extent the character of self-fertility is transmitted from the parent plant to its progeny. This involves the possibility of isolating strains which, under conditions of continued self-fertilization, will tend to become homozygous for a relatively high degree of self-fertility.

Seed-setting, under conditions of artificial self-pollination, has been studied in five successive selfed generations. In table VII is presented the distribution of the inbred plants on the basis of the average number of seeds produced per spike. Owing to the very unfavorable climatic conditions, the seed production in 1926 was very low both in the self-pollinated and in the open-pollinated plants. For this reason lower seed number classes are used for the 1926 results. It will be observed that the seed-setting of the

TABLE VII.

The distribution of timothy plants according to the average number of seeds produced per spike under conditions of self-fertilization

Year	Selfed Generation	SEED NUMBER CLASSES OF TIMOTHY FOR 1923, 1924 1925																						Total	Mean seed production per spike
		3*	8	13	18	23	28	33	38	43	48	53	58	63	68	73	78	83	88	93	98	103	106		
1923	1st	8	3	4	2		1			2														20	13
	2nd	7	1	2	3	3	1		1	1	1		1											21	19
1924	1st	21	4	3	2		1							2										33	10
	2nd	29	9	11	8	5	4	3	2	3	2	1	1											78	15
	3rd	30	12	11	9	8	7	2	3	3	6		1		1									93	17
1925	1st	11	3	4	2	1	1		1	1		1	3											28	18
	2nd	14	9	2	14	2	2			1	3	2	2				1	1			2		1	56	24
	3d	84	17	8	6	2	4	3		1	2	2	2	1	2	2	3		1			1		141	14
	4th	104	27	12	8	8	7	6	4	4	7	1	1	1		1								191	12

Year	Selfed Generation	SEED NUMBER CLASSES FOR 1926																						Total	Mean seed production per Spike
		0	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5	19.5	20.5		
1926	1st	13	2	1	1		1																	18	0.5
	2nd	31	5	3	1	2		1					1											44	0.7
	3rd	49	10	5	8	8	6	7	2	2	3	3	1		1			1						106	2.3
	4th	51	13	23	12	16	4	9	2	2			1										1	134	2.0
	5th	67	7	12	7	7	1	1				1												103	0.8

1924	0	Average number of seeds produced by 150 open-pollinated spikes	340
1925	0	Average number of seeds produced by 150 open-pollinated spikes	350
1926	0	Average number of seeds produced by 1400 open-pollinated spikes	56

* The seed number classes are designated by the center value of each class, thus 3—0.5 to 5.5, etc.

open pollinated plants in 1926 was approximately one-sixth of that of the open-pollinated plants for each of the years 1924 and 1925.

The results presented in this table indicate a great variation, the seed-production of the individual plants, ranging from 0 to 108 seeds per spike. It will be noticed that a great majority of the plants were rather highly self-sterile. For instance, in 1925, if the results of all generations are considered, it will be found that, out of the 416 selfed plants, 213 produced on the average less than 6 seeds per spike. A further analysis of the seed-production for 1925 reveals the fact that of the 213 low-producing plants 4 did not produce any seed, 84 gave an average of only 1 seed per spike and 35 produced 2 seeds per spike. On the other hand, a small proportion of the plants produced an average of over 40 seeds per spike and may therefore be classed as rather highly self-fertile. In general, there is an increase, up to and including the third generation, in the average number of seeds set per spike. The mean production for the years 1923 to 1924 varies from 10 to 24 seeds per spike, and if we consider the large number of spikes produced by the average timothy plant, it becomes quite evident that sufficient seed can be obtained for the continuation of the inbred lines year after year.

Great variability in seed-setting was observed among the progenies of selfed plants in the early generations. This was especially true of the first and second generation selfed lines. As inbreeding proceeded, however, strains were isolated, some of which bred true for relatively high self-fertility while others proved to be consistently low seed producers. A detailed study of eight representative lines selfed for three or four successive generations is given in table VIII. It will be noticed that the first two lines segregate in the early selfed generations and subsequently breed true for high or low fertility. The third line originated from a fruitful individual plant which continued to breed true for a relatively high degree of fertility, while the fourth and eighth lines appearing in the table originated from rather unfruitful parent plants and continued pure for a low degree of fertility. In the fifth line we have an example of a rather unproductive individual plant giving rise to two uniformly high fertility strains. In each of the two re maining lines, numbers 6 and 7, in the table, segregation occurs in the first generation grown from self-fertilized seed. In later generations the progeny of the unfruitful F_2 segregates continue pure for low seed-setting, while the more fruitful plants of the F_2 population produce progenies that segregate for seed-setting in the succeeding generation. The examples given are fairly typical of the lines studied in each of the years 1924 to 1926, inclusive, and the behavior of these lines clearly indicates that under conditions of continued self-fertilization, strains may be isolated that are more or less homozygous for high or low fertility.

As a further test for the inheritance of self-fertility in timothy, a number of correlation co-efficients were calculated. A comparison was made of the average number of seed per spike in successive selfed generations. The correlation co-efficients obtained are given in table IX. In the series of correlation co-efficients for the relationship of seed-setting between parent and progeny, each individual plant of the progeny was correlated with its progeny line mean. In the third series the plant line means and their progeny line means were used. During the period that the lines are segregating for the character of seed-setting, the correlation co-efficients of the second series are probably the most satisfactory in that the mean seed production of the progeny line when correlated with the production of the parent plant should then be a better measure of inheritance than the co-efficients obtained by correlating the seed production of each plant of the progeny with that of its parent. As the various lines become relatively homozygous for seed production, the co-efficients as obtained in the third series would become a more dependable measure of the extent to which seed-setting is inherited.

In table IX it can be seen that there is a very marked correlation for seed-setting between the first and second, and also between the second and third selfed generations. This relationship also persists to a lesser but significant degree in the later generations. It should be borne in mind for those correlation co-efficients where the 1926 results are studied that the conditions during that year were very unfavorable for seed production.

TABLE VIII. Pedigree of eight self-fertilized lines, with the average number of seeds per spike produced in each selfed generation.

	SELFED GENERATION							
	1st		2nd		3rd		4th	
	Cult. and plant No.	No. of seeds per spike	Cult. and plant No.	No. of seeds per spike	Cult. and plant No.	No. of seeds per spike	Cult. and plant No.	No. of seeds per spike
1)	19-1	10.6	1-3	10	13-8	80		
			-7*	28	-12	30		
			-13	25	-13	62		
			-15	50	-15	45		
			-16	22.5				
			-20	3.5	14-4	0.7		
					-9	4.4		
					-12	7.6		
					-15	3.5		
2)	——	——	31-2	12.4	13-3	27.5	84-5	27.7
					-5	3.5	-9	16.1
					-11	20.6	-10	22.5
					-17	20.0	85-1	3.4
							-2	2.0
							-4	2.0
3)	42-61	63.8	8-4	17.3				
			-9	9.6	22	6.4†		
			-15	7.7	23	5.9†		
4)	42-64	11.0	9-1	4.2	24	1.0†		
			-5	6.6				
			-7	4.7				
			-16	6.5	26	0. †		
5)	——	——	5-4	13.5	29-6	8	62.1	44.0
							-4	27.7
							-11	37.5
					-8	9.5	63-1	38.4
							-5	54.5
							-12	28.5
							-17	60.0
6)	20-1	18.5	3-2	6.5	17-4	4.0		
			-13	16.7	-7	0.2		
			-14	15	-16	0.5		
			-19	3	-18	0.7		
					18-2	2.8		
					-3	12.5	32	0.87†
					-7	70.5	33	2.6 †
					-9	66.6	34	
					-19	6.0		
7)	21-3	41.8	20-1	40.1				
			-9	18.0	29-5	0.7		
					-14	2.2		
					-18	32.5		
			-13	42.8	30-10	70.8		
					-14	55.5		
					-18	20.0		
					-20	2.2		
			-16	4.6	31-2	1.0		
					-7	0.2		
					-18	0.4		
8)	23-1	3.1	40-3	5.2	44-1	2.0		
					-6	3.9		
					-7	1.4	60	0 †
					-12	1.0		
					-14	0.4		
					-19	0.6		
			-9	2.0	45-5	0.3		
					-6	3.5		
					-10	9.5	62	3.9 †
					-8	3.0	61	0 †
					-11	4.0	64	0.76†

TABLE IX

Inheritance of seed-growing in timothy as determined by correlation coefficients.

Generations correlated	Years of study	NATURE OF CORRELATION					
		1st Series: Parent plant and progeny individuals		2nd Series: Parent plant and progeny line mean		3rd Series: Parent line mean and progeny line mean	
		Number	Correlation coefficient	Number	Correlation coefficient	Number	Correlation coefficient
1st with 2nd	1923-24	32	0.4687±0.0929	18	0.6199±0.0979		
	1924-25	18	0.7395±0.0721	12	0.8447±0.0554		
2nd with 3rd	1923-24	41	0.9593±0.0084	21	0.8271±0.0464		
	1924-25	22	0.4584±0.1137	32	0.5409±0.0841	32	0.4163±0.0982
	1925-26	106	0.2832±0.0597	25	0.2097±0.1290	25	0.6621±0.0758
3rd with 4th	1924-25			11	0.1460±0.1026		
	1925-26	110	0.1676±0.0622	20	0.3414±0.1331	20	0.2735±0.1396
4th with 5th	1925-26			21	0.1768±0.1424	21	0.2563±0.1372
1st with 3rd	1923-25	22	0.0666±0.1432	32	0.0542±0.1186		
1st with 4th	1925-26			20	0.2788±0.1392		
2nd with 4th	1924-26			20	0.2110±0.1412	20	0.2903±0.1383
3rd with 5th	1924-26			21	0.2503±0.1377		

There is also a rather marked and persistent correlation between the fruitfulness of plants in one selfed generation and that of their descendants two or three generations removed. For instance, when the seed-setting of the first selfed generation is compared with that of the fourth, a correlation co-efficient of 0.2788 ± 0.0371 is obtained.

In the interpretation of these results one must take cognizance of environmental influences. It is quite possible that physiologic disturbances, brought about by climatic conditions or by the enclosure of the spikes during the flowering period, may prevent the full expression of certain hereditary characters. Such influences may also have a differential effect and may influence the seed-setting of some plants more than others. Thus, difference due to genetic causes may be more or less masked by environmental conditions. It should be noted also, as subsequently presented, that seed-production in timothy is positively correlated with vigor of plant as expressed in terms of yielding ability. This relationship would have its greatest effect on seed-setting during the early segregating generations when the plants within a selfed line are somewhat variable in their degree of vigor.

From the data presented, it appears certain that the characters of high and low self-fertility in timothy are inherited. The correlation co-efficients presented in table IX are significant in almost every case, and corroborative evidence is contained in table VIII where it is to be seen that, under conditions of self-fertilization, segregation occurs and strains are isolated which breed true for high or low self-fertility. These results agree with those of Hayes and Barker (12) who observed a marked correlation between the percentage of seed set under various conditions.

Self-fertilization in Relation to Uniformity and Vigor

The occurrence of chlorophyll deficiences in the seedlings of selfed lines, and the tendency for the elimination of these undesirable characters, under conditions of self-fertilization, has been mentioned previously. These weak plants soon died and so were eliminated in the seedling stage. Data were taken on the normal plants both in the greenhouse and later as they grew in the field. Photographs were taken of several different

types, care being taken to select plants that were typical of the lines they represented. These photographs are comparable as regards the size of the plants shown.

Within each of the inbred lines the plants appeared more or less uniform after being selfed for one or two generations. Much variation was observed, however, among the plants grown from open-pollinated seed, some being rather compact and others very open in habit of growth. These plants also varied much in leafiness, coarseness of leaves, number of culms and other characters (Plate II). Many of the selfed lines differed widely from each other. In certain cultures the plants were uniformly of an erect, compact habit of growth while in others a more dwarfed and open type prevailed. This difference is well illustrated in Plate III. The plants in the upper group were 36 inches in height while those shown in the lower part of the plate averaged about 26 inches. Marked differences were observed also in the number of culms produced per plant and in the number and coarseness of the leaves. For instance, in the two-year selfed culture No. 59 most of the plants were characterized by few culms, coarse leaves and long open spikes (Plate IV-A.) Another variation of interest was the occurrence of yellow anthers. These were observed in eight out of the 20 plants comprising culture 17, grown in 1925 from second generation selfed seed. Three of the plants having yellow anthers were selfed and they produced only 0.2, 0.5, and 0.7 seeds per spike, respectively.

The vigor and yielding ability of the self-fertilized lines, on the average, is not markedly reduced. The distribution of the various lines on the basis of their average moisture-free weight per plant in grams is presented in table X. Owing to the unfavorable climatic conditions in 1926, the yield tests of that year were taken on the second year's growth of the cultures started in the spring of 1925. For this reason the distribution for 1926, as presented in table X, is not comparable with that of the preceding years.

The moisture-free weight of hay obtained from the first year's growth of different cultures ranges from about 8 to 80 grams per plant. It is quite evident that both low- and high-yielding strains have been isolated. A number of the lines in each selfed generation were low yielders. One of these, culture 95, contained 15 three-year selfed plants which varied from 12 to 18 inches in height, and the average yield for this line was only 8 grams per plant (Plate IV-B).

In contrast to the lack of productivity in some of the self-fertilized lines shown are relatively high yielders, in some cases outyielding the most vigorous of the commercial checks. For instance, in 1924, the two-year selfed line No. 55 yielded 76 grams of moisture-free hay per plant, while the average yield of the nearest commercial checks was only 61 grams per plant. The plants of this line, three of which are shown in plate V-A, were rather uniform for habit of growth and other characters of economic importance. One of the highest yielding lines harvested in

TABLE X.
Distribution of timothy lines on the basis of their average moisture-free weight per plant, in grams

Year of study	Selfed generation	Yield classes of timothy																		Total number of lines	Mean weight per plant
		8	13	18	23	28	33	38	43	48	53	58	63	68	73	78	83	88	93		
1924	Checks						1			2	2		2	1	1					9	56
	1st							2		1	2	4	3	3						15	57
	2nd						2	3		4	3	2	1	1		1				17	50
1925	Checks			1				1		1										3	35
	1st				1	1	5	6	3		5		2							23	42
	2nd	1	1	3	4	5	5	9	8	4	1									41	34
	3rd	1	2	4	5	4	3	11	6	2	3									41	33
1926*	Checks												1	1		1				3	69
	1st		1	2	1		2	4	2	2	3				3		1	1	1	23	49
	2nd			1	2	4	1	1	2	4	8	4	2	6		2	1	2		40	53
	3rd		2	1	3	5	8	4	5	2	2	4	1	2	2					41	41

*From second year's growth of plants started in 1925.

1925 was the two-year selfed culture No. 10, the plants of which were the progeny of the same parent plant as those shown in plate V-A. In its second year's growth this line averaged 109 grams of moisture-free hay per plant while the average weight of the plants in the nearest commercial check was 93 grams. Each of the 22 plants comprising this line closely simulated those shown in plate V-B.

The yields of ten of the highest yielding self-fertilized lines of the second and third selfed generations are compared with those of the nearest commercial checks in table XI. The yields were calculated on the basis of the dry matter weight in grams per plant. The plants were started in the spring of 1925 and the weights given represent the total yield of hay obtained during the normal growing season of 1925, together with that of the very unfavorable season of 1926. Notes were taken on the uniformity of the plants within each line and these are presented also in the table.

The plants in each of these selfed lines were rather uniform for the characters studied such as vigor, height, habit of growth, number of culms, leafiness, coarseness of leaves and culms, length and density of spikes and time of flowering. Some of the self-fertilized lines have greatly outyielded the commercial strain and they also excel in uniformity of the characters of chief economic importance. It might be mentioned that the plants in culture 77, which outyielded the nearest commercial check by 59 per cent., are the progeny of an individual plant of culture 10 (Plate V-B).

As previously stated, some weak and some desirable strains have been produced, and it is quite evident that some of the inbred lines have maintained their vigor under conditions of self-fertilization, and due to their uniformity of type have outyielded the commercial mixture.

The inheritance of yielding ability in timothy was studied by means of correlation coefficients. The co-efficients obtained, together with a statement of the generations and yields correlated are presented in table XII.

TABLE XI.

Highest yielding self-fertilized lines of timothy compared with their nearest commercial checks. Moisture-free weight per plant, in grams.

Original source	1925-26 culture No.	Selfed generation	Number of plants 1925	Number of plants 1926	Uniformity	Total yield 2nd yr.	Relative yields Nearest check	Relative yields Selfed line
Univer. Farm Sel.	18	2nd	10	20	Good	114	100	97
Cornell 1620	35	"	10	20	Fair	121	100	103
Cornell 1635	38	"	10	19	Good	117	100	102
Cornell 1635	39	"	10	20	Good	119	100	103
Cornell Cross	100	"	10	17	Good	104	100	141
Cornell Cross	101	"	10	12	Good	122	100	165
Cornell Cross	102	"	10	15	Good	109	100	146
Cornell 1777	77	3rd	10	16	Good	118	100	159
Cornell 3230	97	"	10	14	Fair	123	100	166
Cornell 3230	89	"	10	14	Good	107	100	145

TABLE XII

Inheritance of yielding ability in timothy as determined by correlation coefficients.

Selfed generations correlated	Yields correlated	Number of lines	Correlation coefficients obtained
with 1st	2-year average of 1923 and 1924 with that of 1924 and 1925	15	0.5084 ± 0.1291
1st with 2nd	2-year average of 1924 and 1925 with that of 1925 and 1926	27	0.2541 ± 0.1200
2nd with 3rd	1924 with 1925	35	0.2052 ± 0.1092
1st, 2nd, 3rd	1924 with 1925	41	0.3025 ± 0.0953

The co-efficient of 0.5084 ± 0.1291 indicates a significant correlation between the yields of the open-pollinated parent plants and those of their progenies in the first selfed generation. This is in agreement with the observations made by Webber (32). When the yields of successive selfed gererations are compared the correlation is found to persist, but to a smaller degree. A slightly greater coefficient is obtained when the yields of all the selfed generations grown in 1924 are correlated with those of 1925. In general, the co-efficients obtained are not large and environmental factors probably greatly influence the results.

These results together with the fact that uniformly high- and low-yielding strains have been produced justifies the conclusion that the character of yielding ability in timothy is inherited, and that relatively homozygous, self-fertilized lines may be obtained that will outyield the best commercial strain.

Inter-relationships of the Characters of Vigor, Rust Reaction and Seed Production

The relationship between vigor and rust reaction in timothy is apparently a physiologic one. The plants transferred to the field in the spring of 1922 had been tested for rust reaction in the greenhouse. With many of the lines two series were planted in the field, one consisting of resistant plants and the other of susceptible ones. The susceptible plants were heavily inoculated with rust i the greenhouse and they did not grow as vig orously as the resistant plants during the firs year. All of the plants were harvested i 1923, the moisture-free weight in grams pe plant was determined and the average yiel per plant for each line was calculated. Th frequency distributions of yield in relatio to rust reaction are presented in table XIII It will noticed that, on the average, the su ceptible cultures yielded much less than th resistant ones, there being nearly 40 per cen difference in their main yields.

The severe rust epidemic of 1925 did no develop early enough in the season to influ ence the yield trials of that year, but appea ed on the secondary growth during Augus and September. The plants were examine and classified on the basis of their rust re action, as previously described. In table XI the frequency distributions of yield in rel tion to rust reaction in the 107 lines harves ed in 1925 are presented. Lines in which a the plants had been placed in class 0, 1 or are classified as resistant, while those in clas es 3 or 4 are here classified as susceptibl The heterozygous class includes those line which contained both susceptible and r sistant plants.

As the plants were harvested before t rust epidemic developed, the correlation o yield and rust reaction furnished an oppo tunity of study whether there was a genet relationship between these characters. Th

TABLE XIII

Frequency distributions of yield in relation to rust reaction in inbred lines of timothy harvested in 1923.

Rust class	Yield classes, moisture-free weight per plant in grams.											Total No. of lines	Mean yield
	8	13	18	23	28	33	38	43	48	53	58		
Resistant	1	3	1	3	2	2	5	1	2	1	3	24	34.0
Susceptible		2	4	4			1					11	20.7

TABLE XIV

Frequency distributions of yield in relation to rust reaction in the 107 lines of timely harvested in 1925.

Rust class	Yield classes, moisture-free weight per plant in grams												Total No. of lines	Mean yield
	8	13	18	23	28	33	38	43	48	53	58	63		
Resistant	2	3	8	2	5	8	11	6	3	4		2	54	33
Heterozygous	1			4	2	2	10	4	4	2			29	37
Susceptible		1		2	3	2	6	5	1	4			24	38

TABLE XV.

Frequency distributions of seed production in relation to rust reaction in the 107 lines of timothy grown in 1925.

Rust class	Seed classes, average number of seeds per spike													Total No. of	Mean
	3	8	13	18	23	28	33	38	43	48	53	58	63	lines	yield
Resistant	22	10	11	5	5	4	5	1	1	1	1		1	67	14
Heterozygous	10	8		2	1		1				1			23	10
Susceptible	4	3	3	1	3	1	1		1					17	15

data presented in table XIV, however, clearly show that no such relationship was manifested. Both high- and low-yielding lines appear in each of the rust classes and on an average the susceptible lines slightly outyielded the resistant ones. It appears evident, therefore, that while there is a physiologic relationship between vigor and rust reaction in timothy, these characters are inherited independently.

An attack of stem rust preceding or during the flowering period would undoubtedly affect seed production in timothy. During the rust epidemic of 1925, both the commercial plants and those grown from selfed seed were studied in order to determine whether or not there was a genetic relationship between rust reaction and seed production. As the rust did not develop early enough in the season to affect the seed production of that year, any relationship that might be found to exist between these characters would probably be due to genetic causes. The secondary growth of each of the plants that had been self-pollinated was carefully examined and classified on the basis of its rust reaction. In table XV is given the frequency distributions of seed production in relation to rust reaction in the 107 lines studied. The same rust classes are used as in table XIV, but in this case only the plants that had been selfed are included in the study.

Both high and low seed producers appear in each of the rust classes and there is no significant difference between the resistent and susceptible lines as regards the average number of seeds produced per spike. There is apparently no genetic relationship between rust reaction and seed production in timothy.

A study was made also, of the correlation of yielding ability and seed-setting in the lines studied in 1925. In order to obtain a clear picture of the results, a correlation table is presented (Table XVI). Considering seed-setting as the dependent character, a regression line has been drawn to show what change takes place in seed production for a unit change in yielding ability The regression line was determined from the formula

$$X = (\bar{X} - r_{xy}\frac{S.D.\ X\ \bar{Y}}{S.D.Y.}) + r_{xy}\frac{S.D.\ X\ Y.}{S.D.\ Y}$$

In this formula $\bar{X}$= the mean for seed-setting, $\bar{Y}$= the mean yield, S.D.X= the standard deviation for seed-setting, S.D.Y= the standard deviation for yields, r_{xy} = the correlation coefficient and Y= and arbitrary yield class value. A correlation coefficient of 0.1812 ± 0.0628 was obtained, which is barely three times its probable error. Although this coefficient is a low one, it will be noticed that in a general way the number of seeds set per spike increases as the yield increases, up to a certain point, and the fact that it does not continue to increase beyond this point may be partly accounted for by the smallness of the number of lines in the higher yield classes. It must be remembered, too, that environmental factors such as climatic condition during the flowering period, as well as differences in morphologic characters such as length and density of spike, may markedly influence the amount of seed produced by the different strains.

Taking everything into consideration, one is probably justified in concluding that the characters of yielding ability and seed-setting in timothy are correlated to a slight degree at least.

TABLE XVI.

Correlations of yield and seed-setting, 1925.
(Classes for number of seed set per spike in 1925.)

Classes for moisture-free weight per plant in grams, 1925	1	4	7	10	13	16	19	22	25	28	31	34	37	40	43	46	49	52	55	58	61	64	Total
1																							0
4		1																					1
7				1						1													2
10																							0
13	1																						1
16	2			1																			3
19	3					2						1											6
22	2		1		1		2																6
25	1		1		1	1		1															5
28	3	2		2				1															8
31	1	2	2	2						1													8
34		1	1	1									1			1							5
37	4	4	2		2					2	1	2	1			1			1			1	21
40	1	1	1	2	1	1			2		1												10
43	1	3		3				1	1										1				10
46	1	1	1	1							1												5
49			1			1	1	1			1												5
52		3			1	1		1															6
55				1		1		1															3
58																							0
61															1								1
64								1															1
	20	18	10	14	6	7	3	7	3	4	4	3	2	0	1	2	0	0	2	0	0	1	107

$r = 0.1812 \pm 0.0628$

——— =Regression line.

DISCUSSION OF RESULTS

From the results obtained it appears reasonable to conclude that selection within self-fertilized lines is an effective and practical method of breeding timothy. Many plant breeders have recently adopted this method in the improvement of widely different kinds of crop plants. In general, self-fertilization of normally cross-fertilized plants has been found to result in the isolation of relatively homozygous lines which are more or less reduced in vigor and which differ in definite morphologic characters. In corn (30, 6), red clover (24), turnips (9) and perennial rye grass (19), the reduction in vigor appears to be very marked, while in such crops as alfalfa (25), rye (2) and sunflowers (28) certain selfed lines were found to be as vigorous as the commercial strain.

In timothy the results obtained in the present study, in common with those obtained by McRostie (28), clearly show that on the average the self-fertilized lines are not greatly reduced in vigor and yielding ability. Relatively homozygous lines were obtained which differed from one another in habit of growth and in other morphologic character of economic importance. While a few of th self-fertilized lines were markedly unprodu tive, the majority of them compared ver favorably with the commercial checks an some of them significantly outyielded th commercial variety.

The fact that it is possible to isolate dis tinct morphologic types that continue to b vigorous under conditions of self-fertiliza tion is of interest from the standpoint of se ecting strains adapted to particular enviro mental conditions. Jenkin (19) stresses thi point in his report on "self and cross-ferti ization in *Lolium perenne*." In timothy ce tain types may be preferable as a hay cro while others may be better suited for pastur purposes.

From the conclusions arrived at in the pre sent study, together with those of Hayes an Stakman (15) and Barker and Hayes (1) it is quite evident that rust resistant strains o timothy may be rather easily obtained. Re sistance and susceptibility to stem rust wer found to be differentiated by a single mai factor, with resistance dominant. Thus, b inducing a rust epidemic and selecting th

resistant plants for several successive selfed generations, the susceptible types can be rapidly eliminated and homozygous resistant strains obtained.

It thus appears certain that, by selection within self-fertilized lines, strains of timothy may be obtained which, by virtue of their uniformity, rust resistance, vigor and high-yielding ability, will be superior to the commercial sorts.

It is not entirely clear why self-fertilization leads to such marked reduction in vigor in some crops such as corn, red clover and turnips, and why in other crops such as timothy some vigorous selfed lines can be obtained. The differences in the effects of selfing in these crops must be due to differences in genetic condition.

The work of many investigators has shown that, in maize, abnormalties of many kinds occur with exceptional frequency. The factors concerned have been found widely distributed throughout the entire chromosome complex and nearly all of them behave as recessives in inheritance. When it is remembered that the characters of vigor and yieldability must be dependent upon a large number of genetic factors, also located in nearly all chromosomes, it becomes apparent that in addition to the growth factors being more or less closely linked with each other they must also be linked with many deleterious recessive factors. This may account for the fact that thus far it has been found impossible to obtain selfed lines of maize which are as vigorous as the open-pollinated varieties from which they have been obtained.

In such crops as timothy and sunflowers the difference in inherited vigor of growth in selfed lines as compared with that in maize may be due to the presence of fewer harmful recessive factors, or to the dependence of vigor and yielding ability upon fewer favorable growth factors, or both. If then some of the more important factors for growth were independently inherited or linked to a small extent, a less marked reduction in vigor of selfed lines in these crops might be expected. One cannot answer this question with any degree of certainty, however, without further and more intensive research.

SUMMARY

1. Selection within self-fertilized lines of timothy for from one to five successive selfed generations has led to the production of relatively homozygous lines which differ from one another in hereditary morphologic characters. While a few of the selfed lines are markedly reduced in vigor, the majority of them compare very favorably in yielding ability with the open-pollinated commercial strain. Many of the plants proved to be rather highly self-sterile although a small proportion of them are relatively fruitful.

2. Chlorophyll-deficient seedlings, most of which are albinos, are of frequent occurence in selfed lines of timothy. Lack of chlorophyll development in white seedlings appears to be due to the interaction of at least three complementary recessive factors, all of which must be present in a homozygous condition for the production of a white seedling. The allelomorphs of these recessives are regarded as duplicate factors.

3. In a study of the reaction of selfed lines to stem rust it was found that there is a marked correlation between the rust reaction in the field and in the greenhouse. Resistance and susceptibility appear to be differentiated by a single main factor with resistance dominant. There is some evidence of modifying factors which influence the degree of resistance or susceptibility.

4. The characters of high and low self-fertility are apparently inherited. Segregation occurred in the early selfed generations, after which many of the lines bred relatively true for seed production. Significant correlation coefficients were obtained when the seed production of parent plants was compared with that of their progeny. While a small proportion of the plants are relatively fruitful, the majority of them appear to be rather highly self-stertile. The average number of seeds produced per spike under conditions of self-fertilization is approximately 4 per cent. of that produced by open-pollinated plants.

5. While the plants grown from open-pollinated seed are very variable, most of the selfed lines appear rather uniform after being selfed for one or two generations. The various selfed lines differ from one another in habit of growth as well as in many other characters of economic importance.

PLATE I.

A. A view of the tiimothy plot in 1924 which shows the method used to protect the heads from cross-pollination.

B. A view of the timothy plot in 1925. Vegetable parchment bags were used in place of the Kraft paper bags used in 1924.

6. Yielding ability appears to be inherited, as indicated by the correlation coefficients obtained when the yields of successive selfed generations are compared, as well as by the fact that uniformly high- and low-yielding lines have been obtained. On the average the self-fertilized lines are not markedly reduced in vigor. While a few of them are very unproductive, others significantly outyielded the best commercial variety.

7. An attack of stem rust may greatly reduce the yields in timothy. The relationship, however, is a physiologic one as the characters of vigor and seed production are each inherited independently from that of rust reaction. Vigor of plant and seed production appear to be correlated to a slight extent at least.

8. From the results obtained in this study, in common with those obtained by other investigators, it is quite evident that selection within self-fertilized lines is an effective and practical means of improving timothy.

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PLATE II.

Timothy grown from commercial seed. The plant on the right is very open in habit of growth, while the other two are of a somewhat more compact type.

PLATE III.

A. Culture 45. A one-year selfed line of timothy. This line is very erect, and compact in habit of growth. The plants averaged 36 inches in height.

B. Culture 1. A one-year selfed line in which the plants averaged only 26 inches in height. The 22 plants in this culture were uniform for this somewhat open type.

PLATE IV.

A. Culture 59. A two-year selfed line of timothy. Few culms, coarse leaves, and long, open spikes characterized most of the plants in this line.

B. Culture 95. A three-year selfed line which was uniform for this dwarfed, low-yielding type. The plants in this line varied from 12 to 18 inches in height and yielded on the average only 8 grams of moisture-free hay per plant.

PLATE V.

A. Culture 55. First season's growth of a two-year selfed line in 1924. The plants of this line averaged 38 inches in height and yielded 76 grams of moisture-free hay per plant, while those of the nearest commercial check averaged 35 inches in height and yielded 61 grams of hay per plant.

B. Culture 10. Second year's growth of a two-year selfed line in 1925. The plants of this line were from the same progenitor as those shown in plate V-A and they outyielded those of the better commercial checks.

What Our Insects Cost Us.

ARTHUR GIBSON

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How many people realize the tremendous struggle which is being waged continuously against injurious insects? The average individual little realizes the extraordinary power of destruction which these small creatures develop when they appear in outbreak form, the comparative ease with which they devastate fields of growing grain, orchard trees bearing promising crops of fruit, forest and shade trees, or even dried products kept in store. It would seem that little belonging to man escapes injury from some kind of destructive insect. Our field, garden, and orchard crops, our stored products—grain, dried foods, fur, etc.—collectively are reduced in quantity every year to the value of many millions of dollars. Added to this, millions of dollars worth of timber is annually lost as a result of the work of wood borers and other forest insects. Then too, there are the various kinds of mosquitoes, black-flies, houseflies, bedbugs, etc., which affect the health of man and some of which even spread such diseases as malaria, typhus, tuberculosis and infantile paralysis. Live stock, also, suffer untold agonies from the bites of bloodsucking flies, and others as well, some of which enter their bodies, living in the stomach and other parts of the animal. And so the struggle goes on. Is it any wonder that high authorities are predicting that man's next great war will be the war against the insects?

Insects indeed are expensive creatures. The losses they cause are truly enormous. The annual devastation in Canada from insect enemies, in the aggregate is well over $100,000,000. The value of field crops grown in Canada in 1926 was $1,121,177,100; the value of fruit crops $19,595,151—a grand total,—field and fruit crops—of $1,140,772,251.* Estimates made by entomologists have shown that from 10% to 20% of our standard crops are annually destroyed by insect enemies. Ten per cent of the total value of our field and fruit crops in 1926 would amount to $114,000,000, which amount would represent the minimum losses to such crops in the various provinces of Canada. To this, of course, should also be added the losses to forest and shade trees, stored products, etc. These we are unable to estimate with any degree of certainty but during recent years so far as our forests are concerned, these losses have undoubtedly averaged over $50,000,000, each year. In the United States, the total annual bill of damage charged to destructive insects, has been placed at two billions of dollars.

According to Canada Public Accounts (1926) there was spent on war and demobilization, during the years 1915 to March 1926, the sum of $1,694,557,202. During the same period, the losses in Canada from destructive insects, adopting a minimum estimate of $125,000,000. a year, would for the eleven growing seasons, amount to $1,375,000,000, a difference of about $320,000,000, in the cost to Canada between the total amount spent on war and demobilization and the amount charged up against insect enemies.

Referring to losses to field crops, the late C. Gordon Hewitt, stated in 1918: "The annual loss caused by insects to our field crops in Canada represents, if the money value be expressed in wheat, sufficient wheat to feed the entire population of Canada for one year." So far as losses in the United States are concerned, Dr. L. O. Howard, Chief of the Bureau of Entomology, Department of Agriculture, Washington, D. C., has stated this in another way, namely, "Each year (in the United States) the expended labor of approximately one million men is lost through the efforts of insects to feed and propagate."

Foreign Introductions Responsible for Biggest Losses

Many of the worst insect pests of agriculture, horticulture and forestry, are not native

*Monthly Bulletin of Agricultural Statistics—Department of Trade and Commerce, Ottawa, Jan. 1927.

to Canada but are invaders having come to us from foreign countries, particularly in years gone by when importations of nursery stock and other plant products on arrival were not subject to inspection by government officials. Examples of these are as follows:

The Hessian Fly which has caused most destruction to growing wheat, the losses in some years amounting to many hundreds of thousands of dollars, was first found in Canada in 1816. It is a European insect, the general impression being that it was introduced into north-eastern sections of the United States by the Hessian troops during the year 1776. Since then it has spread throughout North America and is now present in most of the important wheat-growing sections. In 1900, it was estimated that the losses in the United States, to growing wheat, from this insect alone, amounted to $100,000,000.

The Gipsy and Brown-tail Moths, both European insects, the former first found in Massachusetts in 1869 and the latter in the same state in the early nineties, have both spread very considerably since these dates, and limited infestations of both species have been found in Eastern Canada. Few insects have been so costly as these two moths. Millions of dollars have been spent on their control during the last twenty years in the New England states. The infestation of the gypsy moth in Eastern Canada has been satisfactorily dealth with and that of the brown-tail moth practically brought under control.

The European Corn Borer, another immigrant, threatens the important corn growing areas of the United States and Canada. It is considered as possibly the greatest menace to agriculture in the United States at the present time. In view of its spread towards the great corn belt of the Central States, the United States Government recently appropriated the sum of $10,000,000, to be used in 1927 in an attempt to "clean up" infested areas in the hope that this will retard the further spread of the borer. This experiment is the most gigantic undertaking of all time so far as the control of an injurious insect is concerned. In Canada, the borer since 1921 has effected very serious injury to sweet and field-grown corn, but it is hoped that the "clean-up" measures now in effect in the province of Ontario will materially reduce the infestation.

The Codling Moth, one of the worst of the orchard pests "came from Europe probably during the eigtheenth century" and is now established in the apple growing regions of Canada and the United States. It has been estimated that in Ontario this insect causes an annual loss of $2,000,000. In the United States the yearly loss is stated to be $12,000,000 to which should be added a further sum of $4,000,000, the cost of fighting it.

The Large Larch Sawfly, also of European origin, was first found in Eastern Canada in the early eighties. Introduced without its native parasites, it spread very rapidly and destroyed from fifty to one hundred per cent of the native larch and tamarack. It is again appearing in destructive numbers, necessitating special attention from our forest entomologists. .

Native Insects Also Cause Losses

Every year in Canada serious losses are caused by many species of insects native to the Dominion. These insects appear in outbreak form at intermittent periods, their abundance in any one year being dependent on natural control factors, such as parasitic and predacious insects, diseases, climatic conditions, etc.

Among the various species which have appeared in numbers sufficiently large to cause spectacular damage, mention may be made of the following:

GRASSHOPPERS. These insects were present in the Prairie Provinces in the years 1919 to 1923 in such enormous numbers as to cause concerted action on the part of the Governments of Manitoba, Saskatchewan and Alberta, necessitating expenditures amounting to $1,779,668; approximately 72,000 tons of poisoned bait were spread over the infested fields, as a result of which crops worth over $77,000,000 were saved to the farmers.

CUTWORMS AND ARMYWORMS. Some kinds of these noctuid caterpillars annually cause important losses to field and garden crops. The red-backed cutworm, in the years 1925 and 1926, caused damage to grain crops, amounting to $6,000,000 in the province of Saskatchewan alone. The pale western cutworm, one of the chief prairie species, has, also, during recent years been very destruc-

tive in Alberta and Saskatchewan, causing losses amounting to many hundreds of thousands of dollars. The armyworms, fortunately, do not appear in destructive numbers every year. The most recent outbreak of the true armyworm in Eastern Canada was in 1914, when it caused an estimated damage to oats, corn and other crops of $300,000.

THE CHINCH BUG. This insect has been known in North America since 1783. During the years 1850 to 1915, it caused losses in the United States amounting to the enormous sum of $350,000,000. Fortunately the chinch bug has not developed to anything like the same extent in Canada, but during some years it has been responsible for important injury to meadow grasses, wheat, corn and oats, in the province of Ontario.

THE WESTERN WHEAT-STEM SAWFLY. In the Prairie Provinces of Western Canada the wheat-stem sawfly has, some years, reduced the yield of wheat to a very appreciable extent. In 1921 for instance, the actual crop affected exceeded a million acres and the losses undoubtedly totalled $2,000,000. In 1926 the losses in Saskatchewan were reported to be $12,000,000.

WIREWORMS. These soil-infesting insects which attack the roots of cereal plants are very important pests in the larger grain producing areas, particularly in Western Canada. During recent years they have caused losses to prairie crops amounting to millions of dollars.

THE SPRUCE BUDWORM. Very serious outbreaks of this insect have appeared in Eastern Canada during the last twenty years. Important stands of spruce and balsam have been entirely killed as a result of injury caused by the caterpillars. On many thousands of square miles 80 per cent of the balsam trees have died. In the Entomological Branch bulletin on the spruce budworm (1924) the following statement by F. J. D. Barnjum appears: "The 150,000,000 cords of pulpwood that have been destroyed by the budworm in the province of Quebec means more than fifty years' supply for our pulp and paper industry at present rate of consumption. This amount of wood manufactured into paper at today's price represents a loss to Canada of seven billion dollars."

Government Warfare

Applied entomology, or the study of destructive insects, is today demanding the attention of nearly every Government in the world, and in the development of this important branch of natural science, Canada has certainly taken a leading part. Canada first appointed an official entomologist in 1884, but the real development and expansion of the work did not begin until about 1909 when the finding of the dreaded browntail moth in shipments of nursery stock from France, necessitated the passing of legislation in 1910 giving the department power to inspect plant products entering Canada. In order to render efficient service to farmers and others, the federal Entomological Branch has, during the last decade, been strengthened very considerably.

THE ORGANIZATION. The headquarters of the Branch are in the Birks Building, Ottawa. In addition to my own Administrative Division, in the work of which I have as an associate Dr. J. M. Swaine, four important Divisions have been established, namely, Division of Field Crop and Garden Insects, (H. G. Crawford, Chief); Division of Forest Insects (J. M. Swaine, in charge); Division of Foreign Pests Suppression, (L. S. McLaine, Chief); and Division of Systematic Entomology, (J. H. McDunnough, Chief). In addition to the work undertaken by officers attached to these Divisions, other entomologists are engaged on investigations relating to fruit insects, live stock insects, greenhouse insects, stored product insects, household insects and so on.

In the various provinces research laboratories are maintained, each in charge of a trained entomologist. In addition, too, the Branch has established plant inspection stations at such ports as St. John, N.B.; Montreal, Que.; Toronto and Niagara Falls, Ont.; Winnipeg, Man.; and Vancouver, B.C. As a result of the maintenance of these laboratories and stations, farmers, fruit-growers, gardeners and others are being served promptly by resident workers who are in close touch with local conditions and thus able to give timely advice when insect outbreaks occur.

The work of the officers of the Division of Field Crop and Garden Insects has to do with the bionomics and control of such important

pests as cutworms, grasshoppers, European corn borer, Hessian fly, root maggots, etc.

Officers of the Division of Forest Insects are investigating such pests as the spruce budworm, the destructive bark-beetles, the larch sawfly, the tent caterpillars, the tussock moths, the fall webworm, pine boring insects, and so on.

The Division of Foreign Pests Suppression is concerned specially with the administration of the regulations of the Destructive Insect and Pest Act, in so far as insects are concerned. This work necessitates the examination of plant products entering Canada at various ports in order to intercept dangerous pests. Scouting of areas possibly infested with pests such as the European corn borer and the gypsy moth is conducted during the summer months.

The care and development of the National Collection of Insects is the chief concern of the officers of the Division of Systematic Entomology. Canada now possesses one of the most important insect collections on the continent. A museum showing the life-history of various kinds of insects is open to the public, and many visitors are attracted thereto.

In the province of British Columbia, entomologists at laboratories located at Victoria, Vernon and Agassiz, are studying the habits and control of such pests as the strawberry weevil, the European earwig, the satin moth, various caterpillars attacking fruit trees, bark beetles and other forest and shade tree insects, etc. At Banff, Alta., the study of mosquitoes has been specially developed.

In the Prairie Provinces, officers attached to laboratories at Lethbridge, Alta.; Saskatoon, Sask.; and Treesbank, Man.; are specially investigating the life-histories and control of important pests which attack wheat and other grain crops, such as cutworms, wireworms, and stem-infesting maggots. At Indian Head, Sask., a laboratory has been established to assist in the control of insects which attack forest and shade-trees and pests which attack live stock.

In Ontario, laboratories are maintained at Ottawa, Strathroy and Vineland, the two first named to investigate field crop and forest insects, the last fruit crop insects. In addition, a fourth laboratory is maintained at Chatham for the purpose of breeding strong colonies of parasites of the corn borer, which are liberated alive in areas where the borer is causing important damage.

In Quebec, a laboratory at Aylmer is concerned with biological investigations relating to forest and shade trees, and one at Hemmingford has been established particularly for the study of insects attacking fruit trees.

In the Maritime Provinces, laboratories are maintained at Fredericton and Annapolis. Studies of insects attacking fruit and vegetable crops as well as forest trees are in progress, and at the Annapolis laboratory, particularly, insecticide investigations are being conducted to discover cheaper and better poisons for use in insect control.

Financial Values Resulting from Entomological Investigations

Following results from experimental and investigational work advice is being continually given to farmers, fruit growers, foresters and others, by officers of the various Divisions and Laboratories of the Entomological Branch. Such advice results in the protection of crops of all kinds from the ravages of injurious insects, which protection is worth many hundreds of thousands of dollars every year to Canada. It is impossible to follow up these constant recommendations in order to estimate their monetary value. For instance, the production of the apple crop alone in Canada depends very largely upon the results of entomological and pathological studies.

Discoveries made by our entomologists have and are resulting in great benefit to Canada. Briefly some of these are as follows:

During the recent widespread and destructive outbreak of grasshoppers in the Prairie Provinces, improved poisoned baits were devised, and adopted generally. The provinces of Manitoba, Saskatchewan and Alberta, in the years 1919-1923, with the co-operation of federal entomologists, developed a most successful campaign of control as a result of which it was estimated that crops worth $77,000,000 were saved to the farmers.

Bark-beetle control work in British Columbia, in recent years devised and conducted by the Entomological Branch, in co-operation with Provincial and Dominion Forest Branches, has resulted in the saving from

total destruction of stands of yellow pine worth more than $6,000,000.

In Ontario, in 1920, our entomologists discovered a dreaded insect—the European corn borer. Since that year the pest has spread to an alarming extent and caused serious damage to field and other corn. An intensive study of the pest and its control has been made and the fact demonstrated that the insect can be brought under control if the farmers will co-operate and see that every part of the corn plant is disposed of before June 1.

A few years ago the whole grape crop of the Niagara district, Ont., was seriously attacked by a destructive insect known as the leaf-hopper. The crop of the following year, commercially, would have been very small indeed had not the entomologists studied the problem and directed an active control campaign among the growers.

Quite recently it was thought that the growing of pears in Ontario would in future be impossible owing to the presence of the pear psylla. This tiny insect reduces the vitality of the trees to such an extent that no marketable crop is possible. Through studies, however, made at the Vineland Entomological Laboratory, it was demonstrated under large orchard conditions that a certain oil spray destroyed the insect and made possible the growing of excellent crops of pears. This new remedy is worth many thousands of dollars to the growers.

The spruce budworm, the most destructive forest insect of recent years has, as already mentioned, destroyed balsam and spruce timber valued at many millions of dollars. Detailed studies made by our forest entomologists indicate that outbreaks of the future may be avoided by an improved system of forest management by which the balsam stands are utilized before they become mature so that only young and thrifty balsam stands are retained, and the reproduction of spruce especially encouraged.

In some areas in Eastern Canada old insect infested orchards, practically abandoned by the growers have been taken over by our entomologists, the insects studied and within two or three years paying crops secured. These orchards have demonstrated the value of intelligent spraying, or other treatment and have proved excellent object lessons.

Cutworms, which annually destroy all kinds of field and garden crops, have been specially studied during recent years. Research conducted in the Prairie Provinces indicated that it is possible to foretell outbreaks of the very destructive pale western cutworm and thus avoid loss to grain crops. In other parts of Canada new poisoned cutworm baits have been devised, the use of which has resulted in savings to crops amounting to many thousands of dollars.

In Manitoba, as a result of studies made at our Treesbank laboratory, it was found that the larvae or grubs of the wheat-stem sawfly do not cut the stems of wheat until the plants begin to lose their sap. As a result of this important discovery farmers in one year were advised to cut their grain a little on the green side before the work of the insect caused the stems to fall over. As a result of this early harvesting crops worth over $3,500,000 were saved.

The various kinds of white grubs, so destructive to field crops, require three or four years to complete their various life stages. For a number of years the Entomological Branch has had these insects under close observation, as a result of which it is now possible to predict the year when the grubs are specially destructive. 1926 was the year in Quebec province when the grubs in the soil were of the size to be specially destructive to the roots of field crops. A statement regarding the presence of the insect, including recommendations to avoid injury was given wide publicity. It is impossible to estimate the actual savings which resulted therefrom, but this undoubtedly would represent a considerable sum of money. In every instance where the advice of our entomologists was not followed, farmers reported very serious losses, especially to potatoes, strawberries and corn.

The control of mosquitoes at Banff, Alta., conducted recently, has undoubtedly assisted in no small way in the increase of visitors, particularly in 1924 and 1925 to the Rocky Mountains National Park. The leading newspapers in Alberta have given excellent publicity to the fact that tourists may now visit Banff without fear of meeting swarms of mosquitoes.

Important progress has been made in the development of new and cheaper poisons for

insect control. The adoption of special localized spray schedules prepared by our insecticide entomologists have resulted in greatly improved crops and decidedly better market prices. In the province of Nova Scotia where a special insecticide laboratory is maintained very excellent service is rendered to the growers. The Annapolis Valley during recent years has harvested excellent crops of apples. In the successful development of such crops, the entomologists can certainly claim an important part.

Inspection of Nursery Stock

The inspection of nursery stock is an important part of the work of the Entomological Branch. Insects introduced into a new country like Canada, where conditions such as temperature, humidity, plant growth, or other environmental factors are different. and when too, they have not been accompanied by native parasitic or other enemies, very often find that in the new habitat every facility is present to enable them to develop rapidly and take on new feeding habits and attack nursery stock or other plants upon which in their native country they are not a pest of any importance. It is for this reason that inspectors employed by the Entomological Branch are constantly on the lookout for any forms of insects present on importations of plants or plant products from foreign countries. In this inspection work, the inspectors have frequently intercepted dangerous insect enemies, particularly on plants imported from Europe. The work of the officers engaged in such inspection work may in brief be compared to that of a police system which is maintained to preserve law and order. Without such system, crime would be prevalent and the country as a whole disorganized. In the absence of our plant inspection service, dangerous pests would, undoubtedly, become introduced and the country as a whole put to great expense for their control.

Dominion Department of Agriculture Notes.

SEED BRANCH

Dominion Grants for Seed and Fertilizer Competitions.

General Rules.

(A) The total subvention that any province may be entitled to receive shall be not more than one-half of the money which it has awarded in prizes to bona fide competitors of seed crop competitions, combined seed crop and cleaned seed exhibitions, or one-half of the money paid on account of co-operative fertilizer demonstrations. The total subvention payable to any province in any fiscal year shall not exceed the sum of $1200 unless more than one million acres are under cultivation in field crops within the province, in which case the subvention may be increased pro rata $1200 for each additional million acres under cultivation in field crops as shown by the report of the Dominion Bureau of Statistics for the previous year; provided, however, that the total subvention to which any province may be entitled on this account shall not exceed the sum of $1200 pro rata per one hundred thousand of total population as shown by the latest available federal census returns.

(B) The Minister of Agriculture for the province may: (1) with the advice of a provincial seed board appointed by him, design the necessary regulations to govern seed crop competitions, combined seed crop and cleaned seed competitions, seed fairs, and provincial seed exhibitions, and the awarding of prizes therefor; (2) with the advice of a provincial fertilizer board appointed by him, design the necessary regulations to govern co-operative fertilizer demonstrations and the disposition of the money therefor; (3) with the advice of these boards determine the proportion of total subvention available for the aforementioned seed competitions and the co-operative fertilizer demonstrations.

Amounts Available for Seed Competitions.

(C) The amount of the subvention shall not exceed $50 for a seed crop competition,

$200 for a completed, combined seed crop and cleaned seed competition, $50 for a seed fair, and $600 for a provincial seed exhibition. Subvention payments will not be made on more than one provincial seed exhibition held in any province within a fiscal year unless more than two thousand acres of seed crops have been inspected and judged for competitions, and two provincial seed exhibitions will be considered the maximum number in any province during the year. Subventions will not be paid on account of seed crop competitions or seed fairs when the same competitors have also entered the combined seed crop and cleaned seed competitions.

Amounts Available for Co-operative Fertilizer Demonstrations.

(D) The amount of the subvention shall not exceed $100 for a co-operative fertilizer demonstration conducted by any one agricultural society or group of farmers. For the purpose of these demonstrations, lime or other soil amendments may be considered as fertilizer.

DAIRY AND COLD STORAGE BRANCH

There is more or less confusion in the minds of the public respecting the definite activities of the different Branches of the Federal Department of Agriculture. As a matter of information on this point the following chronological record of the inauguration of services under the Dairy and Cold Storage Branch is given. This record does not include any of of those services which were instituted previous to 1906, when the Branch was divided, and which are now administered by the Branches which were created at that time.

Dates *Services*

February 1, 1890—Dairy Commissioner appointed.

1891—Staff of dairy experts appointed.

1891-3—Organized and operated the first winter creameries in Canada.

—Introduced the Babcock Milk Tester and demonstrated the fairness of paying for cheese milk on basis of fat content.

—Organized and operated cheese factories in Prince Edward County.

1892-5—Organized and conducted Dairy Schools at St. Hyacinthe, Que., and Kingston, Ont.

1895 —Refrigerator car services for the transport of butter, and inspection of same.

1895-1905—Assisted in the organization and operated creameries in Northwest Territories.

1897 —Promoted the installation of refrigerating machinery in trans-Atlantic steamers, and made the export of butter possible under modern conditions.

1900 —Instituted the present system of cargo inspection at Canadian and United Kingdom ports, which resulted in many reforms in the handling of perishable products from Canada.

1902 —Established cool cheese curing rooms at four centres and demonstrated the importance of control of temperature in curing cheese. Many cheese factories are now equipped for this purpose.

1904 —Started the Cow Testing movement in Canada, since which event there has been a thirty per cent increase in the average yield of Canadian cows. This work was turned over to the Live Stock Branch in 1923.

1907 —Began the encouragement of the building of local cold storage warehouses to preserve the surplus products during flush production to periods of non-production and thus enlarged the market.

—First inspectors employed to prevent fraud in the manufacture and sale of butter and cheese, affording protection to the consumer and the honest manufacturer.

1910 —Began the collection and dissemination of international statistics and general information on the progress and development of the dairy industry throughout the world, which has been featured by the Dairy and Cold Storage Branch ever since.

1912-1924—Established and operated the Finch Dairy Station as a ocmbined cheese factory and creamery to demonstrate the advantages of a large factory equipped to sell milk or cream or to manufacture butter or cheese and thus secure the best possible return for milk according to the demand for the time being.

1914-1918—During the war period the Branch acted as agent for the Imperial War Office in the purchase, preparation and shipment of hay, oats and flour, handling over $100,000,000 worth of these products. In 1917 and 1918 the Commissioner was a member of a Commission that handled the exportable surplus of butter and eggs.

1919 —Began the publication of a weekly Dairy Market Report covering butter and cheese. Also a service of telegraphic reports twice a week. First issue of the monthly Dairy News Letter.

1921 —Utilization of milk and its products first encouraged, by appointment of Lecturers and Demonstrators.

1922 —Monthly Cold Storage News Letter first published.

1923 —Established the system of grading all cheese and butter for export. In 1923 there was 78 per cent of Special and First Grade cheese. In 1925 there was 85.9 per cent of Special and First Grade.

—Division of Scientific Dairy Research established.

1925 —Steps were taken to standardize butter boxes and the branding of same.

June 1, 1927—Regulation effective providing for standard butter boxes, uniform branding, and the marking of the date of manufacture on all butter exported.

LIVE STOCK BRANCH

The growth in the Record of Performance work carried on by the Live Stock Branch has reached a point where to meet the demands of the interested herd owners and to continue to establish adequate credential for dairy animals through the Record of Performance, it has become necessary to increase the staff of inspectors considerably. The Minister of Agriculture has recently approved of the establishment of ten new positions to be distributed througout the various provinces. These positions are now being filled by the Civil Service Commission.

Following the satisfactory outcome of the initial purchase of horses made last Autumn for the Union of Soviet Socialist Republics by the Dominion Department of Agriculture, a second order for four thousand head is now being filled. Officers of the Live Stock Branch are now in the Western Provinces and British Columbia for the purpose of completing the purchase. Under the agreement as between the Department and the Trade Delegation of the Union of Soviet Socialist Republics, adequate funds have been placed at the disposal of the Department by the U.S.S.R. to cover the cost of the horses delivered on ship board and as well the purchase and delivery on boat of feed required for the ocean voyage. The responsibility on the part of the Department ends once the horses are on board. The Trade Delegation is accompanying the Department's experts who are buying subject to the approval of the Soviet representatives. The shipments will be made in three lots, the first of approximately 1,400 for shipment on or about July 15th, the second, 1,350, about September 5th and the remainder on or about October 25th. The first shipment is being filled as far as possible from the Province of British Columbia.

Concerning the C.S.T.A.

THE CONVENTION

The general report of the Seventh Annual Convention, held at Vancouver from June 16th to 18th, will be published in the next issue of the magazine. It will include the Presidential Address, given by Dr. Creelman, the Annual Report of the General Secretary, the report of the Committees on Educational Policies and Research, as well as details concerning the most important matters of business. The report of the Committee on the Co-ordination of Agricultural Policies, given by Dean E. A. Howes, will not be published in the magazine but will be printed separately and mailed to all members of the Society. The lectures given by Dr. D. L. Bailey and Dr. J. L. Collins will be published in later issues of the magazine.

The Convention decided to make certain changes in the make-up of *Scientific Agriculture* so that it would conform more closely with other scientific journals. No change will be made in the editorial policy and the magazine will continue to publish, with reasonable promptness, any acceptable article dealing with agricultural research, experimentation, education, extension, etc. A more dignified title page will be adopted and there will be a single column page instead of the double column page which has been used up to the present time. These changes will go into effect with the September issue, which will be the first issue of Volume VIII.

While there was considerable enthusiasm over the fact that the Society's membership had reached the creditable total of one thousand, it was felt that it would be well in future, to consolidate this membership and to devote more effort to giving service to the members than in attempting to increase the number of members. For that reason, there will be an immediate attempt made to collect the 1926-27 fees from about 90 members now in arreas, and on July 31st the names of those still in arrears will be removed from the membership list. A more prompt payment of fees for the current year will be appreciated.

The General Secretary will proceed immediately with the preparation of a C.S.T.A. Handbook in order that every member may be familiar with the history of the Society, its constitution and by-laws, its accomplishments in the past and its future plans and policies. This book should be ready for distribution about the latter part of August and it is hoped that it will result in the development of the professional spirit which was so apparent at the Vancouver meetings.

In order to provide a capital or reserve fund for the Society, it was decided to introduce a Life Membership, with a fee of \$100.00 so that those who wished to make a permanent contribution to the Society could do so. Each life membership fee will be refundable in full at any time within twenty years should the Society cease to exist, and may be paid in half yearly or quarterly instalments. Members who have already paid their fees for the current year may become left members by making a further payment of \$95.00. It is hoped that the fund accumulated in this way may remain untouched, both as to principal and interest, and that it will eventually become a permanent endowment fund to which voluntary donations may be made at any time by individuals or corporations interested in the Society's welfare. The names of life members will be published in current issues of *Scientific Agriculture.*

The Dominion Executive has appointed a Committee to act as a Board of Directors for the Bureau of Records and Employment. This Board will meet at an early date and will

attempt to formulate an operating policy for the Bureau. It will also meet at frequent intervals to consider applications from employing institutions and to recommend the names of suitable candidates for existing vacancies. It is felt that the C.S.T.A. Bureau of Records and Employment can do an important piece of work if it is allowed time to develop.

The Eighth Annual Convention will be held at Quebec City in June, 1928. Definite dates will be announced this autumn.

It was quite plain at Vancouver that the C.S.T.A. has taken a permanent place in Canadian agriculture and that it is rapidly becoming a truly professional body, dignified, influential and useful.

Slightly over one hundred members registered their attendance. Every province was represented except Prince Edward Island.

The Dominion Executive Committee reappointed Fred. H. Grindley as General Secreatry for the coming year.

Dr. Creelman, in his Presidential Address, claimed that the three needs of the Society were: (1) capital, (2) suitable headquarters and (3) membership spirit. Once the capital is found, the other two should follow automatically.

Mr. Philip Roy, the newly elected President, carried out his duties in a highly creditable manner. He is already planning the programme for the 1928 Convention at Quebec.

The Convention conferred a Fellowship on Dr. G. C. Creelman and awarded Honorary Membership to Miss E. Cora Hind, Agricultural Editor of the Manitoba Free Press.

VACANCIES AT THE INTERNATIONAL INSTITUTE OF AGRICULTURE. ROME, ITALY.

The Permanent Committee of the International Institute of Agriculture at Rome is prepared to receive applications for the following appointments:—

1 "Chef de Section" specially qualified in Tropical Agriculture.

1 "Rédacteur" specially qualified in Tropical Agriculture.

1 "Rédacteur" specially qualified in Dairy Science.

1 "Rédacteur" specially qualified in Plant Diseases.

1 "Rédacteur" specially qualified in Rural Economics.

1 "Rédacteur" specially qualified in the Trade in Agricultural Products..

The minimum initial emoluments are: For the "Chef de Section"; 35,800 liras per annum. For the "Rédacteurs"; 22,750 liras per annum.

The travelling expenses (2nd class) of successful candidates will be repaid on taking up their posts. Members of the staff living at a distance of over 1,000 kilometres from Rome have a right to the payment once in three years of their travelling expenses to their native countries.

The appointments will be made as a result of an examination of the qualifications of the candidates, in which account will also be taken of their knowledge of languages.

Applications should be addressed to the Bureau of Personnel, Institut International d'Agriculture, Villa Borghese, Rome, and must be received not later than 31st August, 1927.

NOTE:—The normal value of 1 lira is 19.3 cents; the current market value is about 5½ cents. —Editor.

APPLICATIONS FOR MEMBERSHIP

The following applications for regular membership have been received since May 1st,

Allen, Miss M. A. (British Columbia, 1926, B.S.A.) Vancouver, B.C.

Gaudet, Gustave (Laval, 1922, B.S.A.) Albertine, N.B.

Huskins, C. L. (Alberta, 1925, B.S.A.) John Innes Horticulture Institution, London, Eng.

Cooper, R. F. V. (McGill, 1926, B.S.A.) Vineland Station, Ont.

NOTES

C. C. Macdougall (Macdonald '27) is District Representative at Sussex, N.B.

D. Pomerleau (Laval '25) has been appointed Agricultural Representative at Cochrane, Ont.

C. H. P. Killick (Saskatchewan '24) is now with the Dominion Dairy and Cold Storage Branch. His headquarters are in the Parliament Buildings, Winnipeg.

C. O. Asplund (Alberta '26) is now on the staff of the School of Agriculture, Raymond, Alta.

A. L. Hay (Macdonald '21) has been transferred as District Agriculturist from Cranbrook to Kamloops, B.C.

G. C. Hay (Macdonald '16) is in commercial agricultural work. His address is 1645—11th Ave. W., Vancouver, B.C.

J. R. Weston (Manitoba '13) is Field Supervisor for the Soldier Settlement Board at Provost, Alta.

G. J. Callister (O.A.C. '21) is now with the N. V. Potash Export My, 20 West 45th St., New York City.

Members who expect to be in Ottawa during the World's Poultry Congress should not fail to reserve tickets for the C.S.T.A. International Banquet (see advertisement in this issue).

The General Secretary will be glad to receive applications for membership, without the payment of initiation fee, from graduates of 1927.

No change was made in the annual membership fee at the Vancouver Convention, and this remains at $5.00. Members can show their interest in the Society by paying their fees now, either direct to the General Secretary or to their local branch secretary.

On August 1st there will be no members on the active list whose fees are not paid up to June 1st, 1927. It is estimated that about sixty new members will have to be enrolled during the coming year to maintain a membership of 1,000. As the normal annual enrolment is about 125, it is not anticipated that an extensive membership campaign will need to be undertaken.

In all likelihood the Society will become incorporated during the current year. This will constitute another milestone in its history.

It is unfortunate that a larger number of members cannot attend the annual Conventions. Those who were able to visit Vancouver during the recent meetings were all greatly impressed, particularly with the tone of the discussions. It is apparent that the C. S. T. A. is now a permanent institution and that those graduates who are willing to contribute $5.00 per year towards iits maintenance are merely making an investment in something that will eventually produce adequate returns. As a national organization the Society is comparatively young, and its accomplishments up to the present time have more than justified its organization. If every member will give his unselfish support, the Society's future progress and development, as well as its accomplishments, will be even more creditable. Those who can afford to take out life membership should do so, and those who cannot do more than pay the annual fee should make that contribution willingly.

La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

La Production actuelle des Engrais Azotés Synthétiques.

H. M. NAGANT

Institut Agricole d'Oka, La Trappe, P.Q.

(suite du numéro de juin)

Ammoniaque Synthétique et ses Dérivés

Quel que soit le développement actuel ou futur de la fabrication et de l'emploi de la cyanamide de calcium et des engrais azotés obtenus par sa transformation, il ne semble plus douteux que la part du lion, dans la révolution des engrais azotés amenée par la synthèse industrielle, revienne à l'ammoniaque obtenue par hydrogénation directe de l'azote dans le procédé Haber-Bosch et ses variantes.

Rappelons que ce procédé ne fut développé que plusieurs années après la mise en pratique industrielle de la fixation de l'azote sous forme d'acide nitrique et de cyanamide calcique. Les premières études sur la question, par le professeur Haber, de l'Université de Carlsruhe (Bade), et ses collaborateurs, parurent sous forme de mémoires publiés en 1905. Nernst, continuant les expériences de Haber, mit en oeuvre les fortes pressions dans le but de favoriser la combinaison de l'azote et de l'hydrogène et établit le principe de cette synthèse industrielle, fort simple, qui consiste à comprimer sous plusieurs centaines d'atmosphères un mélange formé de trois volumes d'hydrogène et d'un volume d'azote, en présence d'un catalyseur métalique, et à une température de 400 à 500° dans un cylindre à parois très résistantes, pour obtenir la réaction:

$$N_2 + 3H_2 = 2NH_3$$

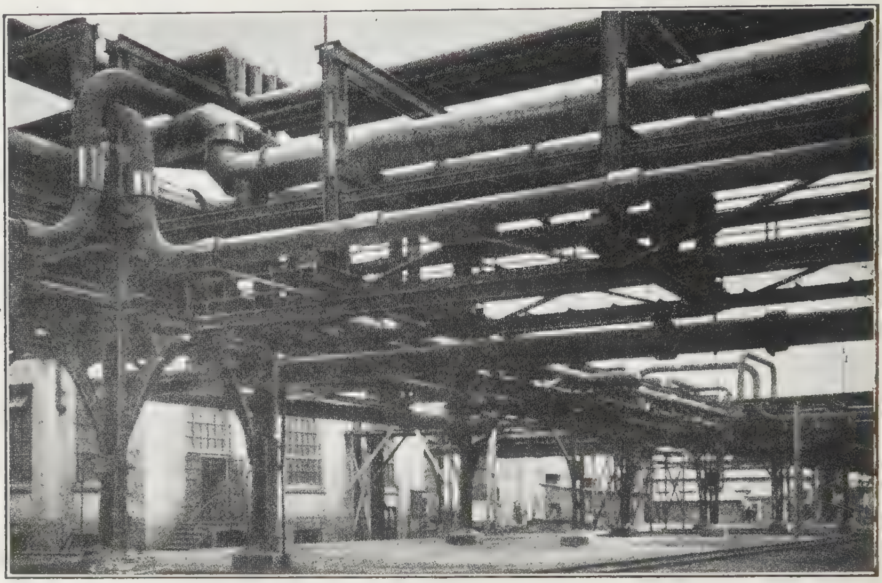
Bref, il s'agissait de réaliser des conditions d'équilibre favorables à l'obtention d'une forte proportion de NH_3, composé qui est d'ailleurs exothermique, dans le mélange gazeux, cette proportion variant avec la pression, la température et la nature du catalyseur employé.

Si le principe de la synthèse de l'ammoniaque semble extrêmement simple, sa réalisation sur une base industrielle était hérissée de difficultés et d'obstacles dans la construction et la mise au point des appareils dont on se fait difficilement une idée. Les problèmes à résoudre étaient de diverse nature, mais pouvaient surtout se ramener aux points suivants:—

1—Trouver un métal ou un alliage résistant à l'effet altérant de l'hydrogène agissant sous une pression de plusieurs centaines d'atmosphères et à une température élevée, pour la construction des appareils. Ainsi par exemple, dans les premiers essais, il fut constaté que l'hydrogène filtrant à travers les épaisses parois des énormes cylindres en acier se combinait avec le carbone du métal pour former du CH_4, lui ôtant ainsi toutes ses qualités de résistance.

2—Etablir des joints étanches pour les gaz soumis aux énormes pressions.

3—Trouver l'agent catalyseur le plus approprié. De nombreux métaux et alliages furent essayés à cet effet, notamment le cérium, l'uranium, l'osmium, le fer, le cobalt, le nickel, etc.



Conduites servant au cheminement du mélange d'hydrogène et d'azote dans les installations de Merseburg.

4—Se procurer la matière première, c'est-à-dire les gaz hydrogène et azote, à l'état de grande pureté. La présence d'éléments étrangers, tels que l'oxygène et la vapeur d'eau, détermine, en effet, une altération rapide, ou comme on l'appelle en language technique, un empoisonnement des catalyseurs.

Avec la ténacité, la méthode et l'esprit de suite qui sont propres aux hommes de science allemands, les techniciens de la puissante firme de matières colorantes, "Badische Anilin und Soda Fabrik", de Ludwigshafen, sur le Rhin, travaillaient dans le secret à la solution de ces divers problémes et à la mise au point des appareils industriels construits à cet effet, lorsqu'éclata la guerre de 1914, amenant une concentration des efforts les plus puissants pour hâter les réalisations sur une vaste échelle.

Des moyens formidables mis en oeuvre, sont sorties les gigantesques usines soeurs d'Oppau et de Merseburg, veritables merveilles de la technique moderne dans l'utilisation au maximum de l'énergie, de la mécanique et des matières premières employées, qui non seulement ont, une fois la guerre terminée, affranchi l'Allemagne de toute importation d'engrais azotés dont elle achetait avant cela des centaines de mille tonnes à l'étranger, pour les besoins de son agriculture, mai[s] en font actuellement un exportateur des plu[s] importants, pour le plus grand avantage d[e] sa balance commerciale et du rétablissemen[t] de ses finances obérées.

Pour ces vastes réalisations, les grande[s] sociétés allemandes s'unirent en une commun[-]auté d'intérêts, connue sous le nom de I. G[.] (Initiales des mots Interessen-Gemeinschaft[)] dont le but principal fut d'assurer l'unit[é] de direction technique. Cette fabrication d[e] quantités prodigieuses de composés azoté[s] synthétiques correspondait d'ailleurs à u[n] besoin de compenser sur le marché mondia[l] la perte d'une forte partie du débouché de[s] matières colorantes résultant de l'établisse[-]ment de l'industrie de ces produits dans l[a] plupart des pays durant la guerre.

On estime en Allemagne, à un milliard d[e] marks or, l'amélioration de la balance com[-]merciale due à la seule industrie de l'azote (9).

Engrais Fabriques a Partir de l'Ammo[-]niaque Synthétique

La variété des engrais prépares par le[s] grandes usines allemandes de fixation d[e] l'azote et mis sur le marché au cours des der[-]nières années est très grande et tend à ré[-]pondre aux besoins les plus divers.

Tout d'abord, il y a naturellement à mentionner:

1—*Le sulfate d'ammoniaque ordinaire*, $(NH_4)_2SO_4$. Ce produit étant connu de longue date des cultivateurs, il est tout naturel qu'une grande partie de l'ammoniaque synthétique soit fixée et vendue sous la même forme que celle provenant de la distillation de la houille et autres matériaux organiques, mais en vue, soit d'obtenir des produits azotés d'une plus grande concentration encore, soit de les vendre sous forme d'azote nitrique, lequel est préférable pour un certain nombre d'usages, ou encore dans le but d'associer à l'azote un ou deux autres éléments de fertilité, tels que l'acide phosphorique et la potasse, de manière à fournir des engrais bivalents ou même complets, d'une haute teneur en matériaux utiles, le Syndicat allemand de l'Azote a préparé avec l'ammoniaque plusieurs combinaisons nouvelles, de haute qualité, qui constituent des nouveautés sur le marché mondial des engrais.

Voici l'énumération des produits connus jusqu'ici, avec leur teneur approximative en azote:

2—*Le Chlorure d'ammonium*, NH_4Cl:—se prépare en fixant l'ammoniaque au moyen d'acide chlorhydrique, ou bien en transformant d'abord l'ammoniaque en bicarbonate d'ammoniaque pour faire ensuite réagir celui-ci avec du chlorure de sodium, comme dans le procédé Solvay appliqué pour la préparation du carbonate de sodium.

3—*Le Leunasalpeter*:—Est un nitrosulfate d'ammoniaque, répondant à la composition: $(NH_4)_3SO_4NO_3$, renferme 26% d'azote environ. Ce nom commercial a été donné d'après les usines de Leuna, où le produit est préparé. Pour obtenir le Leunasalpeter, on mélange tout simplement les solutions de nitrate d'ammoniaque et de sulfate d'ammoniaque qu'il suffit alors d'évaporer jusqu'à siccité pour avoir le sel double désiré.

C'est donc un engrais très concentré, renfermant un quart de l'azote sous forme nitrique et trois quarts à l'état ammoniacal. Il a l'avantage d'agir rapidement par la première forme et plus graduellement par la seconde. La tendance vers l'acidification du sol, qui est cependant moins prononcée que chez le sulfate d'ammoniaque ordinaire, le désigne aussi pour les cultures qui préfèrent les engrais acides, telles que celle de la pomme de terre.

4—*L'Urée*, $CO(NH_2)_2$:—contient à l'état de pureté, 46.6% d'azote. Ce n'est que depuis 1924 que le problême de la fabrication industrielle de l'urée, en partant de l'ammoniaque synthétique fut résolu.

Cet engrais extrêmement concentré présente des avantages tout particuliers pour l'expédition à de longues distances. L'emploi de l'urée a donné de bons résultats dans certaines cultures spéciales, telles que le tabac, le houblon et les produits maraichers.

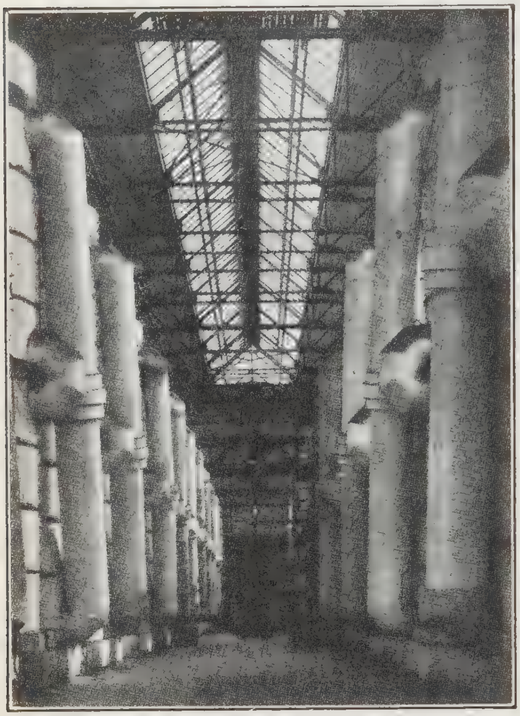
5—*Le Nitrate de soude synthétique*, $NaNO_3$ —Est obtenu en traitant une lessive de soude par de l'acide nitrique préparé lui-même par oxydation catalytique de l'ammoniaque. Le nitrate de soude synthétique se distingue par un état de grande pureté, ce qui permet de l'utiliser dans toutes les industries chimiques, sans raffinage préalable.

6—*Le Nitrate de Calcium* $Ca\ (NO_3)_2$: —(15.5% d'azote). La fabrication de cet engrais a été commencée depuis une année seulement; ce produit qui a déjà attiré l'attention dans le monde entier est donc identique au nitrate de chaux préparé par les usines norvégiennes d'acide nitrique, mais il s'en distingue par une plus grande pureté et une plus forte teneur en azote. Le nitrate de chaux de Norvège, en effet, ne titre en moyenne que 13% d'azote.

7—*Le Nitrate d'ammonium* NH_4NO_3:—Est aussi un composé très riche en azote, résultant de l'union de l'ammoniaque avec l'acide nitrique. A l'état pur, il contient 35% d'azote, mais il a le défaut d'être très hygroscopique et de présenter, paraît-il, des dangers d'explosion. C'est pourquoi on lui a substitué le Leunasalpeter qui possède ses avantages sans présenter ses inconvénients.

8—*Le Diammophos*, $(NH_4)_2HPO_4$:— Est un engrais bivalent, formé de phosphate diammonique pur, contient 19% d'azote et 47% de P_2O_5, obtenu en faisant absorber l'ammoniaque par une solution d'acide phosphorique. L'acide phosphorique consommé dans cette préparation s'obtient par réduction de phosphates minéraux impurs, dans le four électrique, au moyen du procédé allemand Lilgenroth (10).

Cette fabrication se réalise sans intervention de l'acide sulfurique; il y a d'abord



Générateurs d'hydrogène des usines à ammoniaque synthétique de Merseburg, vue interne.

formation de phosphore libre par réduction du phosphate tricalcique au moyen de coke en présence de silice, suivant la réaction théorique:—

$$Ca_3(PO_4)_2+3SiO_2+5(O)=P_2+3CaSiO_3+5CO$$

Le phosphore est ensuite brulé à l'état d'-anhydride phosphorique:—

$$P_2+O_5=P_2O_5,$$

lequel, en présence d'eau, donne de l'acide phosphorique:

$$P_2O_5+3H_2O=2H_3PO_4.$$

Ce procédé permet d'utiliser des phosphates minéraux impurs, impropres à la conversion en superphosphate par la méthode ordinaire (1).

Ce fertilisant présente donc beaucoup d'-analogie avec l'Ammo-Phos, mis sur le marché par la "American Cyanamid Co.". Il est susceptible d'un vaste champ d'application pour les cultures demandant de l'acide phosphorique concentré et très assimilable, telles que le coton.

9—*Le Leunaphos*:—Mélange de phosphate diammonique avec du sulfate d'ammoniaque; contient 20% d'azote et 15% d'acide phosphorique. Ce fertilisant est préparé spécialement pour les besoins de l'agriculture allemande.

10—*Le Nitrophoska*:—Représente un engrais complet, renfermant donc de l'azote, de l'acide phosphorique et de la potasse. On en fabrique actuellement deux variétés: le Nitrophoska No. 1, dosant 17% d'azote, 11.7% de P_2O_5 et 21% de K_2O; le Nitrophoska No. 2, avec 14.7% d'azote, 10.2% de P_2O_5 et 25.6% de K_2O. (10).

Ces fertilisants trivalents sont des associations de nitrate de potassium et de phosphates d'ammoniaque pour lesquelles le chlorure de potassium extrait des mines de sels potassiques de l'Allemagne est une matière première.

Leur production se fait surtout en vue de la consommation intérieure, et, parait-il, pour l'introduction des engrais sur le marché chinois.

Caractère Général de ces Divers Composes Azotés:—Ce qui distingue surtout ces divers engrais azotés préparés en partant de l'ammoniaque synthétique, lorsqu'on les compare aux produits analogues provenant d'autres sources, c'est leur état de grande pureté (11).

Ils peuvent se différencier entre eux par l'état de granulation ou la forme cristalline, mais, tous, ils sont uniformément d'une blancheur immaculée, au point qu'on les prendrait pour des produits pharmaceutiques, chimiquement purs, plutôt que pour des matériaux destinés à être employés comme engrais chimiques.

Les Usines d'Oppau et de Merseburg

Tous les produits énumérés ci-dessus sont donc manufacturés dans deux immenses usines qui, dans la plaine Rhénane, allignent leurs séries de hautes cheminées avec la régularité d'un bataillon de soldats prussiens à la parade. Un coup d'oeil jeté sur le plan général continue à révéler toujours le même souci de l'ordre, de la symétrie et du colossal dans la disposition des bâtiments de fabrication, réservoirs et voies de communication.

Semblables à quelque monstre de l'apocalypse, les gigantesques installations d'Oppau et de Merseburg aspirent l'air atmos-

phérique par centaines de millions, de milliards même, de pieds cubes, qu'elles font circuler par un réseau élaboré de canalisations dans leurs poumons embrasés, soumettant ensuite le mélange gazeux à une compression terrible dans leurs entrailles en acier pour le sortir à l'état solide, sous forme de centaines de mille tonnes de produits destinés à faire surgir comme par enchantement une végétation luxuriante sur des millions d'arpents de sol.

Quelques Chiffres

L'usine d'Oppau, située à deux kilomètres de la ville de Ludwigshafen, sur le Rhin, dans l'ancien duché de Bade, entra en opération au cours de l'été 1913 et produisit pendant le premier exercice 7000 tonnes d'azote combiné, correspondant à 35,000 tonnes de sulfate d'ammoniaque. Durant la guerre et après, elle subit des agrandisssements toujours plus considérables et fut portée à sa capacité actuelle de production qui est de 100,000 tonnes d'azote combiné, soit l'équivalent de 500,000 tonnes de sulfate d'ammoniaque ordinaire, annuellement.

On se rappellere sans doute qu'au mois de septembre 1921, une terrible explosion s'y produisit, creusant dans le sol un cratère de 100 pieds de profondeur et faisant au delà de 1500 victimes parmi le personnel ouvrier et la population environnante. Les causes exactes de la catastrophe sont toujours restées mystérieuses; d'après l'enquête faite par la direction de la Badische Anilin und Soda Fabrik, elle aurait résulté de l'explosion d'un silo contenant 7,500 tonnes de nitro-sulfate d'ammoniaque, matière correspondant donc à la composition du leunasalpeter. Toutefois ce produit ayant toujours été considéré comme ne présentant pas de danger d'explosion lorsqu'il est préparé suivant les règles, il est permis de supposer qu'une erreur fut commise dans les opérations de fabrication ou, plus vraisemblablement peut-être, qu'il s'agissait d'un dépot d'explosifs préparés pour fins de guerre.

Quoi qu'il en soit, les dommages causés ne tardèrent pas à être réparés, et l'usine reprit bientôt toute son activité.

En 1917 fut fondé l'établissement de Merseburg, situé non loin du premier, qui est aujourd'hui en mesure pour fournir annuellement 250,000 tonnes d'azote combiné, correspondant à 1,250,000 tonnes de sulfate d'ammoniaque, ce qui porte la capacité des deux usines réunies à 350,000 et 1,750,000 tonnes, respectivement.

Pour arriver à ce résultat, il s'agit de transformer tout l'azote que contiennent approximativement 385,000,000 de mètres cubes d'air, et, d'autre part, 110,000 wagons de chemin de fer seraient requis pour le transport de cette masse d'azote convertie en sulfate d'ammoniaque. Calculée à la seconde, cette production d'ensemble représente l'union de 9.7 mètres cubes d'azote avec trois fois le même volume d'hydrogène pour former environ 31 lbs. d'ammoniaque ou 124 lbs. de sulfate d'ammoniaque.

Les deux établissements réunis couvrent une superficie de près de 8 kilomètres carrés, soit 2,000 acres. Ils représentent un ensemble d'un millier de bâtiments de toutes dimensions, reliés par un réseau de voies ferrées à section normale, d'une extension de 160 kilomètres, ou 100 milles (13).

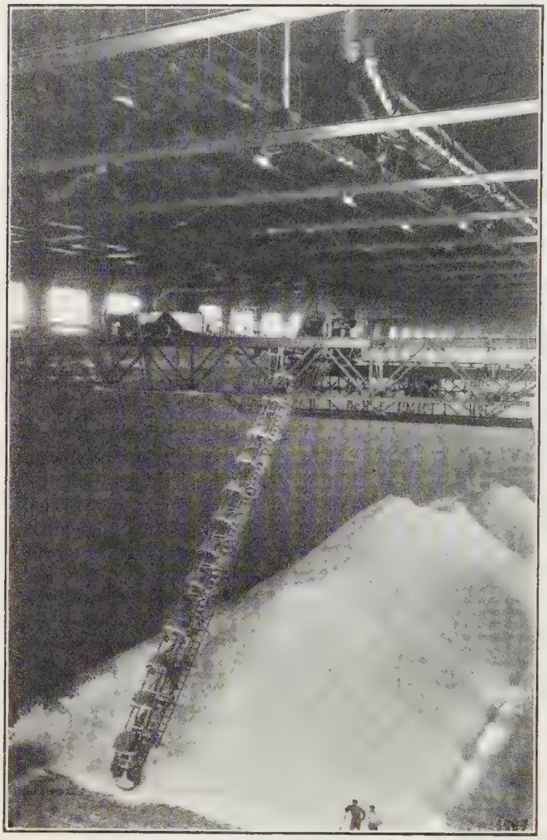
Le mode de fabrication exige l'emploi le plus étendu de machines de tous genres qui servent principalement à la compression des gaz, à leur mise en circulation ainsi que celle de diverses solutions ou mélanges, à l'assèchement et au transport des matières brutes et des produits finis, au chauffage, à l'éclairage etc.

L'énergie nécessaire est fournie d'une part par des moteurs actionnés au moyen de gaz produit dans des générateurs de gaz de lignite, d'autre part par des turbines actionnées par la vapeur.

Le combustible consommé par l'usine d'Oppau est amené régulièrement du bassin houiller de la Rhur, sous forme de houille, de coke et de briquettes de lignite, par des bateaux charbonniers.

Le choix de l'emplacement de l'usine de Merseburg fut dicté par le voisinage immédiat de grands gisements de lignite qui satisfont aux besoins journaliers de milliers de tonnes de ce combustible utilisé pour le chauffage des chaudières.

Oppau compte quatre salles de chaudières, Merseburg en possède sept, lesquelles s'étendent sur une longueur de 1.7 kilomètres, soit plus d'un mille. Les deux établissements possèdent chacun leur distribution d'eau avec d'énormes installations pour la filtration, qui fournissent journellement des centaines de



Fabrique d'ammoniaque de Oppau
Intérieur d'un silo d'engrais chimiques. La Grandeur des deux personnes montre la hauteur des tas d'engrais chimiques.

mille tonnes d'eau pure nécessaire à la fabrication. Quoique la main d'oeuvre soit réduite au strict minimum, grâce à la multiplication à l'extrème des applications mécaniques, ainsi qu'on le montrera plus loin, les usines de la B.A.S.F., emploient un personnel qui, au dernier recensement s'élevait à 20,316 personnes. Suivant le genre d'activités, cette petite armée se répartissait de la manière suivante: 16,500 ouvriers, 1801 contre-maîtres, surveillants et aides, 1134 employés commerciaux ou buralistes, 245 employés spéciaux, 342 employés techniques et 294 ingénieurs et chimistes diplômés.

Marche de la Fabrication

Les deux usines construites sur le même plan général, fournissent de l'ammoniaque synthétique comme produit initial, mais tandis que les établissements de Merseburg fabriquent exclusivement du sulfate d'ammoniaque, ceux d'Oppau préparent les produits diversifiés dont nous avons fait plus haut l'énumération.

Les poumons des monstrueuses installations sont évidemment représentés par les appareils producteurs de gaz, lesquels sont des constructions aux dimensions gigantesques, entièrement édifiées en charpentes métalliques, ajourées. C'est ici l'endroit où les deux matières brutes utilisées dans le procédé long, laborieux et compliqué, l'eau et l'air pénètrent dans le cycle de la fabrication.

Invisibles comme elles le sont à leur entrée, elles le resteront tout le long du cours des transformations, puisqu'il s'agit toujours de matériaux gazeux qui, au moyen de machines, sont sans cesse poussés plus loin et invisiblement, dans de grandes conduites tubulaires, vers des appareils hermétiquement clos, où, invisiblement encore, s'accomplissent les plus formidables réactions chimiques. Le produit final, l'ammoniaque elle-même, reste toujours invisible à nos yeux et ne se manifeste que par son odeur irritante caractéristique, ce n'est qu'au terme extrême de la fabrication, lorsque les courroies sans fin transportant les produits azotés vers d'immenses silos, qu'ils nous apparaissent sous forme de sels blancs comme la neige, qui s'accumulent masses prodigieuses.

Tout le processus de fabrication se déroule en quelques heures, de sorte qu'au cours d'une visite de l'usine on peut, avant de la quitter, retrouver dans le silo, converti en sel fertilisant, l'air qu'on avait respiré en entrant.

Preparation du Melange d'Hydrogene et d'Azote

Les deux éléments nécessaires à la synthèse de l'ammoniaque sont obtenus au cours d'une même série d'opérations consécutives dans l'usine génératrice et cela aux dépens du coke d'une part, de l'air d'autre part. Pour cela, on refoule alternativement à travers de grandes fournaises remplies de coke, de l'air, ce qui fournit comme produit de combustion un mélange gazeux riche en azote et en CO_2; puis, aussitôt, que le coke des générateurs est porté au rouge blanc, de la vapeur d'eau qui fournit, par réduction, un mélange gazeux (appelé gaz d'eau) caractérisé

par sa forte proportion d'hydrogène, suivant la réaction:—

$$C + H_2O = CO + H_2;$$

les gaz sont immédiatement dirigés vers des tours de lavage où ils subissent une première épuration avant d'être amassés dans une série de grandes cloches ou gazomètres.

Notons, qu'au cours de cette première opération, il y a récupération non seulement de tous les sous-produits de l'épuration, mais encore d'un maximum de la chaleur dégagée.

Enrichissement en Hydrogene par Catalyse

Le mélange, suivant des proportions déterminées, des deux espèces de gaz qui renferment, outre l'hydrogène et l'azote, beaucoup d'oxyde de carbone et de l'anhydride carbonique est ensuite conduit plus loin vers une installation dénommée "fabrique d'hydrogène par contact."

Dans les fours de contact, s'opère la première transformation catalytique du procédé Haber-Bosch, qui consiste en une autre phase de réduction de la vapeur d'eau injectée, au contact de l'oxyde de carbone, suivant la réaction:—

$$H_2O + CO = H_2 + CO_2,$$

ce qui se traduit donc par un enrichissement en gaz hydrogène et la transformation de presque tout l'oxyde de carbone en anhydride carbonique.

C'est ici qu'on voit s'ériger, l'un à côté de l'autre, toute une série d'appareils identiques, peints en blanc, entourés d'un réseau de conduites tubulaires absolument déconcertant. Ce qui frappe surtout le visiteur dans cette organisation si compliquée, c'est le grand silence qui y règne et l'absence presque complète d'êtres humains. Pas un ouvrier à voir, pas plus qu'une trace de produit chimique; les réactions formidables accompagnées de puissants échanges d'énergie se passent, silencieuses et invisibles, dans les mystérieux appareils blancs.

Tous les dispositifs automatiques imaginables sont mis à contribution pour l'exécution des opérations, de sorte que toutes les imperfections et insuffisances inhérentes au travail manuel sont éliminées dans la mesure du possible. C'est pourquoi on a disposé partout des appareils mesureurs et enrégistreurs, très ingénieusement conçus, qui contrôlent automatiquement toutes les opérations.

A beaucoup d'endroits l'activité du personnel se borne tout simplement à la lecture des indications de pression, de température, etc., ainsi qu'à l'exécution régulière d'analyses en vue de surveiller constamment la marche de la fabrication.

Ce contrôle général est exercé par un comité spécial, composé de physiciens et d'ingénieurs, auquel incombe aussi la tâche de mettre au point de nouvelles méthodes de mensuration.

Elimination du CO_2 et du CO.

Le mélange gazeux qui sort des générateurs d'hydrogène par contact renferme, en plus de l'hydrogène et l'azote, une forte proportion d'anhydride carbonique et un peu d'oxyde de carbone, qu'il s'agit d'en séparer.

Le CO_2 est extrait tout d'abord en soumettant les gaz à une pression de 25 atmosphères, pour le laver ensuite avec de l'eau, laquelle, dans ces conditions, absorbe l'anhydride carbonique. Celui-ci est récupéré par simple détente de l'eau de lavage et rentre dans le cycle comme principe auxiliaire de la préparation des sels fertilisants.

Ensuite les gaz débarrassés de CO_2 entrent dans des appareils à haute pression où ils sont réduits à 1/200 de leur volume primitif, sous 200 atmosphères environ. A cette pression, ils sont traités par des solutions de sels de cuivre, lesquelles leur enlèvant les derniers restes d'oxyde de carbone et autres impuretés.

Ces deux opérations successives s'effectuent dans d'immenses halls où sont disposées les séries de grandes machines à compression.

Synthese de l'Ammoniaque

Le coeur du Monstre

Après cela, le mélange d'hydrogène et d'azote étant rendu pratiquement à l'état de pureté chimique, il est introduit dans les fours à catalyse sous haute pression, où s'effectue la combinaison partielle à l'état d'ammoniaque.

Nous sommes ici véritablement au coeur du monstre, où tout le travail peut se résumer à une circulation continuelle de gaz sous haute pression, mis en mouvement à l'aide d'un puissant système de pompes.

Au sortir des fours, le mélange de gaz chargé d'ammoniaque est envoyé dans des dispositifs d'absorption où l'eau qu'on y injecte absorbe l'ammoniaque et est amassée ensuite dans de grands réservoirs d'une capacité de 5,000 mètres cubes chacun, à l'état d'eau ammoniacale, dosant 25 à 28% d'ammoniaque.

Les fours à haute pression sont constitués de cylindres massifs à parois en acier devant présenter toutes les qualités de résistance aux pressions, d'une part, aux réactions chimiques des gaz comprimés et chauffés, d'autre part. Aussi est-ce la construction et la mise au point de ces appareils qui soumirent à la plus grande épreuve l'esprit inventif et les connaissances techniques des ingénieurs et chimistes attachés à l'entreprise.

Les fours à haute pression sont formés de plusieurs enveloppes concentriques; l'intérieure est faite en un alliage insensible à l'action corrosive de l'hydrogène, tandis que l'extérieure est construite en acier offrant une grande résistance à la pression. A remarquer aussi que cette enveloppe externe est percée de trous afin que le peu d'hydrogène qui peut filtrer à travers la paroi interne puisse facilement s'échapper sans altérer l'acier.

Le catalyseur granulé, formé de fer contenant un peu d'alumine est disposé au centre du four, dans une enveloppe en terre réfractaire que les gaz traversent de haut en bas. (2).

La combinaison de l'hydrogène et de l'azote est exothermique et dégage 22,000 petites calories par molécule gramme d'ammoniaque formé. Il suffit donc d'amorcer la réaction en portant le mélange gazeux à la température de 600° environ; après cela, la chaleur degagée par la réaction elle-même est utilisée pour maintenir la température de catalyse au degré voulu. A cet effet, un système très ingénieux d'échange de chaleur est établi entre les gaz chauds, chargés d'ammoniaque, qui sortent du four et le mélange froid d'azote et d'hydrogène qui y entre.

Fabrication du Sulfate d'Ammoniaque

Remarquons tout d'abord que l'Allemagne ne possède pas de gisements de soufre ou de pyrite, matières premières nécessaires à la fabrication industrielle de l'acide sulfurique. Dans ces conditions elle serait demeurée tributaire de l'étranger pour ces matériaux si les grandes usines d'ammoniaque synthétique avaient adopté le procédé ordinaire d[e] fabrication du sulfate d'ammoniaque, leque[l] consiste, comme tout le monde le sait, à fair[e] absorber le gaz ammoniaque par de l'acid[e] sulfurique libre.

Mais, le génie des techniciens de la B. A. S. F. sut tourner la difficulté et trouver un[e] méthode ne comportant que la mise en oeuvr[e] de matériaux indigènes, en se servant de gyps[e] dont le pays possède des carrières considér[ables] et notamment dans les montagnes d[u] Harz, où elles furent mises en exploitatio[n] pour les besoins de l'usine de Merseburg.

C'est par trains entiers que ce gypse o[u] sulfate de calcium est amené chaque jour au[x] usines où on commence à le pulvériser fine[-]ment au moyen de grands broyeurs.

Cette poudre de sulfate de calcium est en[-]suite mise en suspension dans de l'eau pend[-]ant qu'on y injecte aussi le gaz ammoniaca[l] et de l'anhydride carbonique.

Par des réactions présentant de l'analogi[e] avec celles qui se passent dans la fabrica[-]tion de la soude au moyen du procédé Solvay[,] il y a formation de carbonate d'ammoniaqu[e] d'abord:—

$$2NH_3 + CO_2 + H_2O = (NH_4)_2CO_3,$$

de sulfate d'ammoniaque et de carbonate d[e] Calcium ensuite:—

$$(NH_4)_2CO_3 + CaSO_4 = (NH_4)_2SO_4 + CaCO_3.$$

On remarquera que le CO_2 employé dan[s] cette transformation est précisément le sous[-]produit de la préparation de l'hydrogèn[e] dans le procédé par contact. Le carbonat[e] de calcium formé étant insoluble, il est sé[-]paré par filtration de la solution de sulfat[e] d'ammoniaque, laquelle est alors évaporé[e] jusqu'à cristallisation. La carbonate de chau[x] qui reste à l'état de résidu n'est plus jeté su[r] le terril, comme cela se pratiquait au débu[t] mais vendu pour servir d'amendement cal[-]caire.

L'ammoniaque peut encore être fixée sou[s] forme de chlorure d'ammonium. Dans ce bu[t] on se sert d'une solution de chlorure de sod[-]ium ou de sel de cuisine ordinaire et d'am[-]moniaque dans laquelle est injecté sous pres[-]sion, le CO_2. C'est donc l'application d[u] procédé Solvay bien connu pour la prépara[-]tion de la soude. Le carbonate d'ammon[-]ium formé en premier lieu réagit par doubl[e] décomposition avec le chlorure de sodiu[m] pour former du chlorure d'ammonium et d[e] carbonate de sodium:

$$NH_4HCO_3+NaCl=NaHCO_3+NH_4Cl.$$

.a seule différence c'est qui'ici le chlorure l'ammonium devient le produit principal et ıe retourne plus dans la fabrication, tandis [ue le carbonate de sodium passe à l'état le sous-produit.

Synthese Industrielle de l'Uree

La synthèse de ce composé azoté très riche, éalise donc le passage de l'azote minéral à état d'azote organique. En principe elle est btenue en chauffant, sous forte pression, un ıélange d'ammoniaque et d'anhydride caronique; dans ces conditions il y a formaon de carbonate d'ammoniaque, lequel se hange partiellement en urée, suivant le réction inverse de celle qui amène la décomosition de l'urée dans le phénomène si connu e la fermentation ammoniacale des urines à étable et à l'écurie:

$$(NH_4)_2CO_3=CO(NH_2)_2+2H_2O.$$

a mise en pratique, sur une base industrielle, e cette transformation qui semble cependant simple, a parait-il, exigé la solution de roblêmes d'une difficulté peu ordinaire.

Acide Nitrique et Nitrates Derives de l'Ammoniaque

C'est encore une fois à l'aide d'un catalyeur, le platine, que l'ammoniaque est oxydé l'état d'acide nitrique, dans le procédé Ostald, par exemple:—

$$NH_3+2O_2=HNO_3+H_2O$$

ıais il faut remarquer que tout récemment s experts de la B.A.S.F., ont découvert et is en application un autre procédé, dans quel le platine, métal extrêmement dispendux, a été remplacé par du fer (1).

Cette combustion se passe dans de vastes urs en maçonnerie et dégage une grande ıantité de chaleur, laquelle est toujours répérée avec soin. Les vapeurs nitreuses sont nduites dans de grandes tours en granite où les sont absorbées par de l'eau dans laquelle l dissout du carbonate de soude, lorsqu'on sire du nitrate de sodium synthétique.

Nous savons que pour passer au nitrate de lcium, il suffit de faire réagir l'acide nitrie sur du carbonate de chaux.

Transport et Emmagasinage des Produits Finis

Comme pour le reste de la fabrication, le ınsport et la manutention des produits sont ganisés de manière à exclure presque enrement l'intervention du travail humain. mesure qu'ils sont formés, les différents sels sont pris par des courroies sans fin, des chaines à godets combinées avec des ponts roulants, et autres appareils de transport intelligemment conçus, pour être amenés vers de vastes entrepôts ou silos en béton armé, où ils s'amassent par petites montagnes en attendant la mise en sac pour l'exportation.

L'usine d'Oppau possède six de ces entrepots dont le plus grand a une capacité de 55,000 tonnes, tandis que celle de Merseburg, laquelle fabrique exclusivement du sulfate d'ammoniaque, peut se contenter d'un silo unique mais aux dimensions gigantesques; ce colosse en béton mesure, en effet, 1150 pieds de long, sur 180 de large et 116 de haut, et peut loger 250,000 tonnes de sulfate d'ammoniaque.

Les appareils de distribution de l'entrepôt de Merseburg sont en mesure d'assurer une expédition journalière de 5,000 tonnes de sulfate. Le chargement dans les wagons de chemin de fer se fait aussi automatiquement.

Inutile d'ajouter qu'aux deux usines se rattachent des laboratoires parfaitement outillés, dont le rôle est non seulement de contrôler les matières premières employées, les différentes phases de la fabrication et les produits destinés à être mis sur la marché, mais encore de s'occuper sans cesse de recherches en vue de perfectionner les méthodes, de résoudre les problêmes encore pendants, de réaliser des économies, de préparer des nouveaux produits dérivés de l'ammoniaque, de récupérer certains sous-produits et de leur trouver une utilisation.

Experiences et Demonstrations avec les Nouvelles Formes d'Engrais Azotes

Jusqu'ici, l'agriculture n'était familiarisée qu'avec une couple de formes d'engrais chimiques azotés: le nitrate de soude et le sulfate d'ammoniaque, sans compter le nitrate de calcium de Norvège offert depuis quelques années.

C'est pourquoi la B.A.S.F. a jugé nécessaire d'organiser sur une base scientifique l'expérimentation des produits azotés nouveaux, ainsi que de leurs combinaisons avec d'autres éléments sorties de ses usines, pour en faire connaitre ensuite les résultats au moyen de démonstrations multipliées.

A cet effet, un grand domaine agricole fut acquis et transformé en station expérimentale, équipée de bureaux, laboratoires, serres chau-

des, etc., de façon à faire les essais d'une manière parfaitement méthodique.

Les serres sont surtout destinées aux expériences en vases de végétation, qui précèdent généralement celles qui ont lieu sur des parcelles en plein air. Aux laboratoires incombe la tâche de faire les analyses physico-chimiques des sols, les recherches biologiques sur les plantes, les expériences de fertilité en rapport avec la bactériologie, etc.

Les Procedes Claude et Casale

Ces procédés ne diffèrent de celui Haber-Bosch appliqué en Allemagne que par l'emploi de pressions beaucoup plus élevées encore dans le four à catalyse. Les pressions atteignent 800 atmosphères dans le premier procédé et 1000 dans le second, de sorte que la concentration de l'ammoniaque devient beaucoup plus forte. Sous une pression de 900 atmosphères le pourcentage d'ammoniaque dans le mélange gazeux atteint 25%, alors qu'avec 200 atmosphères il n'est que de 5% environ. Aussi recueille-t-on généralement l'ammoniaque ainsi formé, par liquéfaction au lieu de la faire absorber par de l'eau comme cela se pratique dans les usines d'Oppau et de Merseburg.

L'emploi des hyperpressions permet aussi de réduire de beaucoup les dimensions des appareils, qui perdent le caractère du colossal que nous avons rencontré partout dans les installations de la B.A.S.F.

Si le procédé Haber est pratique pour l'application sur une grande échelle, dans d'immenses usines centralisées en un endroit, il semble que celui de Claude s'adapte mieux à de petites fabriques dispersées un peu partout et ne visant chacune que la production d'une quantité limitée de produits azotés.

Il peut notamment être associé à d'autres industries comme production secondaire. C'est ainsi que les batteries de fours à coke et les hauts-fourneaux peuvent utiliser avec avantage les gaz de récupération pour en extraire de l'hydrogène, élément qui représente à lui tout seul environ 50% du coût total de la production de l'ammoniaque synthétique, et le convertir en ce précieux produit.

Nous n'avons encore pu trouver que peu de renseignements définitifs sur le nombre d'installations à ammoniaque synthétique fonctionnant avec les brevets Claude ou sur l'importance de leur rendement. Il y a un an, on annonçait que la grande Compagnie d'Explosifs américaine DUPONT, avait acquis les brevets Claude pour les Etats-Uni avec l'intention d'ériger près de Charlesto Virginie, une usine de fixation ayant une ca acité journalière de 25 tonnes d'azote.

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C.S.T.A. Seventh Annual Convention

The more important features of the recent annual Convention of the Canadian Society of Technical Agriculturists, held at Vancouver from June 16th to 18th, are included in this issue. All those who were able to attend the meetings were impressed with the keen interest taken in the business sessions, the recognition given to the Society on all sides, and the splendid manner in which the social features of the programme were carried out.

The principle of meeting in close conjunction with the annual meeting of the Canadian Seed Growers' Association was strongly approved and is expected to be adopted for many years to come. This principle enabled the two organizations to spend the entire day on June 15th in an automobile tour of the district around Victoria, B.C., visiting a number of seed farms, the well-known Butchart gardens, the Dominion Experimental Station at Sidney, and closing the day with a joint banquet at the Empress Hotel, Victoria, as guests of the Provincial Department of Agriculture. The C.S.T.A. meetings opened in Vancouver the following morning and a considerable number of those who had been attending the Seed Growers' meetings in Victoria remained over for the Vancouver sessions.

All of the business sessions were presided over by Mr. L. P. Roy, President-elect of the Society, who succeeded Dr. G. C. Creelman. The retiring address of Dr. Creelman is published in this issue.

It will be noted that the report of the Committee on Co-ordination of Agricultural Policy, which was appointed a year ago, is not published in the magazine. It was considered desirable that this report be printed as a separate publication and mailed to each member of the Society.

Particular interest was taken in the report given by President L. S. Klinck for the Committee on Educational Policies. During the past year it has been possible for President Klinck, as Chairman of this Committee, to visit each of the provinces of Canada and bring the recommendations of the Committee, as adopted at the 1926 Convention, before the proper authorities in each province. The Society is greatly indebted to President Klinck for the continued service which he has given to the organization in this way.

The lectures by Dr. J. L. Collins and Dr. D. L. Bailey, under the auspices of the Dominion Department of Agriculture, were well attended. The two lectures given by Dr. Collins are published in this issue and those given by Dr. Bailey will appear in a later number of the magazine.

The attendance at the Convention was quite up to the average for western meetings. There were eighty-eight members registered as compared with eighty-four at Winnipeg in 1921, eighty-three at Saskatoon in 1923 and ninety-three at Edmonton in 1925.

CONVENTION COMMITTEES

The following committees were named by the Chair on the first day of the Convention and were asked to make reports on the closing day:—

NOMINATIONS: E. A. Howes (Chairman), G. R. Bisby, G. P. McRostie, F. M. Clement.

RESOLUTIONS: L. C. Raymond (Chairman), P. Stewart, W. J. Squirrell, E. M. Taylor.

CONSTITUTION & BY-LAWS R. S. Duncan (Chairman), G. M. Stewart, W. H. Hill, R. Gagnon, K. W. Gordon.

PUBLICATION: A. Kelsall (Chairman), D. H. Galbraith, J. B. Munro, W. Southworth, F. T. Wahlen.

EMPLOYMENT BUREAU: B. L. Emslie (Chairman), W. M. Fleming, F. Foulds, A. W. Mason.

The reports of these Committees, as presented on June 18th, were as follows:—

Nominations Committee

The following were nominated as members of Standing Committees for the coming year:

RESEARCH: G. P. McRostie (Chairman), J. F. Snell, J. M. Swaine, A. T. Charron, E. S. Archibald, with power to add to their numbers.

AFFILIATIONS: L. H. Newman (Chairman), T. G. Major, Arthur Gibson.

Seventh Annual Convention of the C.S.T.A. held at Vancouver, B.C., June 15-18, 1927

CO-ORDINATION OF AGRICULTURAL POLICIES: E. A. Howes (Chairman), F. H. Auld, W. B. Roadhouse, H. Barton, C. F. Bailey, E. S. Archibald, G. H. Clark.

MARKETING EDUCATION: F. M. Clement (Chairman), E. A. Howes, W. J. Rutherford, W. C. McKillican, J. B. Reynolds, H. Barton, Rev. Father Leopold, l'Abbe Noel Pelletier, J. M. Trueman, A. A. MacMillan, P. E. Light.

In addition to the above Standing Committees, the following sub-committees were appointed by the Dominion Executive (Chairman in all cases is named first):—

MEMBERSHIP: G. C. Creelman, G. H. Hutton, A. Pépin.

FINANCE: F. Foulds, M. P. McClellan, W. T. Hunter.

PROGRESS: K. W. Gordon, A. Kelsall, J. A. Ste. Marie.

BALLOT: E. S. Archibald L. H. Newman.

EXECUTIVE COUNCIL: L. P. Roy, M. B. Davis, E. S. Archibald, A. T. Charron, L. H. Newman, G. E. O'Brien, G. C. Creelman, H. M. Nagant, W. H. Brittain.

AUDITORS: L. H. Newman, M. B. Davis.

Representative on Council of American Association for the Advancement of Science: G. E. Sanders.

Resolutions Committee

The following resolutions were submitted by the Chairman of the Committee and approved by the Convention:—

1. RESOLVED that the Dominion Executive Committee consider the advisability of discussing with the Agricultural Colleges, eastern and western, as two groups, the question of organizing special courses on distribution and marketing, and that following the discussion with the Colleges the Executive be given power to act.

2. RESOLVED that this Society regrets the absence through illness of Dr. C. A. Zavitz, a member of the organization since its inception and for forty-one years identified with the subject of scientific agriculture. The Society wishes to express its appreciation of the services rendered by Dr. Zavitz to agriculture and hopes that he may be speedily restored to good health and that we may look forward to his valued counsel at our future Conventions.

3. RESOLVED that we, the C.S.T.A., express our profound sorrow at the loss of one of our most esteemed members and a Fellow of the Society: the late Professor William Lochhead, whose memory is revered by many of us as that of a teacher and guide and by all of us as that of a distinguished colleague and friend.

   BE IT FURTHER RESOLVED that a copy of this resolution and an expression of the deep sympathy of the Society be sent by the General Secretary to Mrs. Lochhead.

4. RESOLVED that the hearty thanks of the Society be tendered to the Chilean Nitrate Committee through their representative Mr. B. Leslie Emslie, for their generosity in supporting financially certain of the important aims of the Society, notably the establishment of a Bureau of Records and Employment, and in helping to ensure the success of this annual Convention by making it possible for the locals of some of the more distant sections to be represented here.

5. RESOLVED that the Society express its deep appreciation to the Federal Department of Agriculture for again providing the necessary funds to enable the Society to arrange a series of advanced lectures for this Seventh Annual Convention, assembled in Vancouver.

   BE IT FURTHER RESOLVED that a copy of this resolution be forwarded to the Federal Minister of Agriculture.

6. RESOLVED that the Society recognize in a tangible way the untiring efforts of the General Secretary in carrying out the increasingly heavy duties of his position. We would respectively request the incoming Executive to carry this into effect by: (1) a substantial increase in salary, (2) the procuring of suitable office accommodation and (3) making provision for adequate assistance.

7. RESOLVED that the members of the C.S.T.A., assembled at the Seventh Annual Convention, tender their hearty thanks for the many kind acts and courtesies received from the following bodies, which helped so greatly to ensure the success of the Convention:—

(1) The Provincial Department of Agriculture and the Provincial Government.

(2) The City of Vancouver.

(3) The University of British Columbia.

(4) The British Columbia local branch of the Society.

(5) The Dominion Experimental Station at Sidney, B.C.

8. WHEREAS the membership of the Society has now reached one thousand, indicating that the men engaged in scientific agriculture in Canada are well organized, and WHEREAS it is the belief of many members engaged in specialized phases of scientific agriculture that the group system of organization, such as prevails in most of the learned societies, is best suited to promote efficient organization and maintain the interest of the members,

THEREFORE BE IT RESOLVED that this Convention endorse the principle of group organization and hereby instruct the Dominion Executive to arrange the 1928 Dominion Convention along these lines and to make such changes in the business management of the Society as will make group organization possible.

Constitution and By-laws

The only important change in the constitution and by-laws of the Society was the addition of a clause providing for life membership, with a fee of one hundred dollars.

A slight change was made in by-law 7 so that nominations for the four named officers of the Society had to be in the hands of the General Secretary by March 15th instead of March 31st. This change was made so that there would be time to submit a copy of the election ballot to each local secretary before mailing it to all members on April 10th.

Publication

The publications committee gave very serious consideration to the Society's official organ, and made the following recommendations:—

1. That the front cover of the journal changed to conform more closely w other scientific journals, and that the ta of contents continue to appear on cover.

2. That the present double column page discontinued in favour of a single colu page.

3. That a committee of three or four (re dent at Ottawa) be appointed by the Do inion Executive to examine existing sci tific journals with a view to determini the best make-up for the Society's journ in accordance with the above.

It was further recommended by this co mittee that as soon as finances would perm a further improvement in the quality paper be effected, and that an effort be ma to publish a series of articles dealing wi various branches of agricultural scien which would furnish a fairly complete bibl graphy of the literature available on the su ject treated.

It is not intended that there shall be a change in the editorial policy of the mag zine, but that it will continue to accept, a publish as promptly as possible, any suitab article dealing with agricultural research, e perimentation, extension, education, etc.

Bureau of Records and Employment

The report of this committee took the for of a resolution, as follows:—

RESOLVED that the Bureau of Recor and Employment has now been developed the stage when it should begin to opera more fully;

That through publicity in a dignified for the Bureau and its advantages be brought the attention of prospective employers enga ed in various enterprises where the servic of technically trained agriculturists mig be utilized profitably:

That the Dominion Executive appoint Board composed of four or five members the Society in Ottawa who would serve an advisory capacity in the further organiz tion of the Bureau and in recommending ca didates for positions to be filled.

MISS E. CORA HIND

lected an Honorary Member of the C.S.T.A. at the Vancouver Convention.

Honorary Membership

For rendering special service to the agri-ultural profession, Miss E. Cora Hind, Agri-ultural and Commercial Editor of the Mani-ba Free Press, was elected an Honorary ember of the Society.

Miss Hind was born at Toronto on Septem-r 18th, 1861, receiving her early education Grey County, Ontario, and her high school aining at Orillia, Ont. In 1882 she went Winnipeg and entered a law office, being e first girl to operate a typewriter in the anadian west. She at once came in touch ith the farmer borrowers of that day and ith their problems. In 1893 she opened an office in Winnipeg as a public stenographer and reporter of Conventions, and in July of that year reported her first farm convention, the Central Farmers' Institute at Brandon. Man. From that time on she steadily increased her reporting of agricultural meetings as well as the publication of articles on farming, all of which appeared in the Manitoba Free Press.

The importance of the wheat crop in the prairie provinces and the development of marketing organizations led Miss Hind into the field of crop estimating and the study of marketing problems. In 1900 she sold out her stenographic and reporting business and joined the regular staff of the Manitoba Free Press. She has always insisted that her success during the past thirty years has been due to the opportunity given her by the Free Press to do work that had never before been done by a woman. She has made astonishingly accurate estimates of every wheat crop in western Canada since 1904, with two exceptions, once because the Free Press decided not to make an inspection, and once because of ill health. She was the first woman to hold a ticket to the floor of the Winnipeg grain exchange.

Miss Hind is a familiar figure at all live stock shows in the Canadian west, at the Royal Winter Fair in Toronto and at the Chicago International. She has been honoured with a Diploma from the Manitoba Agricultural College and is known to agricultural educationalists as a sympathetic friend of agricultural teaching and research. The C.S.T.A. is proud to know that she has accepted Honorary membership.

C.S.T.A. Fellowship

The 1927 Fellowship, awarded for professional distinction, was conferred upon George Christie Creelman, Beamsville, Ontario.

Dr. Creelman was born at Collingwood, Ont., on May 9th, 1869. He graduated from the Ontario Agricultural College in 1888, received his M.S. from Mississippi A. & M. College in 1895 and was awarded an Honorary L.L.D. by McMaster University in 1905. He was Professor of Biology at the Mississippi A. & M. College from 1888 until 1897, Superintendent of Farmers' Institutes in Ontario from 1898 until 1904, President of the Ontario Agricultural College from 1904

Dr. Geo. C. Creelman
Awarded the 1927 C.S.T.A. Fellowship at the Vancouver Convention.

until 1920 and Agent General for Ontario in Great Britain from 1920 until 1921. His health broke down in 1921 and since that time he has been living on a fruit farm at Beamsville, Ontario, in the Niagara Peninsula.

Organization of Horticultural Group

Following a preliminary meeting at the 1926 Convention a group of horticultural workers within the Society have developed a group of about 100 members. Representatives of this group met during the recent Convention and elected officers for the group, as follows:—

Chairman—W. T. Macoun, Dominion Horticulturist, Ottawa.

Vice-Chairman—A. F. Barss, University of B.C., Vancouver.

Secretary—T. G. Bunting, Macdonald College, P.Q.

Executive—W. S. Blair, Experimental Station, Kentville, N.S.; E. F. Palmer, Vineland Station, Ont.; F. W. Brodrick, Agricultural College, Winnipeg, Man.; W. Robertson, Dept. of Agriculture, Victoria, B.C.

In reporting the foregoing organization the Convention, Mr. Macoun strongly recommended the organization of similar groups within the Society, operating without any group fee, but meeting as groups at the Annual Conventions, and doing such work the group members and executive might decide.

Convention Attendance

Of the eighty-eight members who registered at the Vancouver Convention, there were forty from British Columbia, fourteen from Ontario, thirteen from Alberta, eight from Manitoba, seven from Quebec, three from Saskatchewan, and one each from Nova Scotia, New Brunswick and the United States. Their names and addresses follow:—

V. S. Asmundson, Vancouver, B.C.

D. L. Bailey, Winnipeg, Man.; Don. Bark, Brooks, Alta.; I. T. Barnet, Vancouver, B.C.; A. F. Barss, Vancouver, B.C.; E. Bewell, Courtenay, B.C.; G. R. Bisby, Winnipeg, Man.; J. E. Blakeman, Winnipeg, Man.; G. B. Boving, Vancouver, B.C.; P. A. Boving, Vancouver, B.C.; F. W. Brodrick, Winnipeg, Man.; F. E. Buck, Vancouver, B.C.; T. G. Bunting, Macdonald Colege, P.Q.

E. E. Carncross, Cloverdale, B.C.; M. Champlin, Saskatoon, Sask.; H. Chester, Invermere, B.C.; G. H. Clark, Ottawa. Ont.; G. E. W. Clarke, Vancouver, B.C.; F. M. Clement, Vancouver, B.C.; P. R. Cowan, Ottawa, Ont.; G. C. Creelman, Beamsville, Ont.

R. L. Davis, Vancouver, B.C.; G. E. De Long, Lacombe; Alta.; R. S. Duncan, Toronto, Ont.

B. L. Emslie, Toronto, Ont.

W. M. Fleming, Summerland, B.C.; Foulds, Winnipeg, Man.; E. B. Fraser, Vancouver, B.C.; J. R. Fryer, Edmonton, Alta.

R. Gagnon, Quebec, P.Q.; D. H. Galbraith, Vulcan, Alta.; J. W. Gibson, Victoria, B.C.; K. W. Gordon, Saskatoon, Sask.; C. H. Goulden, Winnipeg, Man.; F. H. Grindley, Ottawa, Ont.

H. E. Hallwright, Victoria, B.C.; L. H. Hamilton, Macdonald College, P.Q.; H. B. Hare, Vancouver, B.C.; W. A. Hawley, Ne

AT THE VANCOUVER CONVENTION

Left to right, E. A. Howes, President of the Society 1925-26, G. C. Creelman, President from 1926 to 1927, L. S. Klinck, President from 1920 to 1922, and L. P. Roy, who assumed the duties of President on June 1st, 1927.

Vestminster, B.C.; W. D. Hay, Lethbridge, lta.; R. H. Helmer, Nicola, B.C.; W. H. Iicks, Agassiz, B.C.; W. H. Hill, Vancouver, B.C.; E. A. Howes, Edmonton, Alta; G. H. Iutton, Calgary, Alta.

A. Kelsall, Annapolis Royal, N.S.; H. M. King, Vancouver, B.C.; L. S. Klinck, Vancouver, B.C.

D. G. Laird, Vancouver, B.C.; C. A. amb, Cloverdale, B.C.; G. L. Landon, Nelon, B.C.; C. W. Leggatt, Calgary, Alta.; W. . Leslie, Morden, Man.

W. T. Macoun, Ottawa, Ont.; A. W. Masn, Guelph, Ont.; J. B. Munro, Victoria, B.C.; . MacBean, Agassiz, B.C.; A. H. MacLenan, Guelph, Ont.; G. P. McRostie, Ottawa, nt.; A. McTaggart, Macdonald College, P.Q.

R. Newton, Edmonton, Alta.; R. G. Newon, Invermere, B.C.; W. Newton, Los Angees, Cal.

R. L. Ramsay, Courtenay, B.C.; L. C. Rayond, Macdonald College, P.Q.; A. E. Richrds, Agassiz, B.C.; W. J. Riley, Vancouver, B.C.; H. Rive, Victoria, B.C.; W. H. Robertson, Victoria, B.C.; L. P. Roy, Quebec, P.Q.

W. Southworth, Winnipeg, Man.; G. J. Spencer, Vancouver, B.C.; W. J. Squirrell, Guelph, Ont.; W. J. Stephen, Edmonton, Alta.; G. M. Stewart, Calgary, Alta.; P. Stewart, Ottawa, Ont.; H. G. L. Strange, Fenn, Alta.; R. Summerby, Macdonald College, P.Q.; C. Sweet, Ottawa, Ont.

C. Tapp, Calgary, Alta.; E. M. Taylor, Fredericton, N.B.; D. W. Thompson, Vancouver, B.C.; C. Tice, Victoria, B.C.; M. P. Tullis, Regina, Sask.

G. V. Van Tausk, Victoria, B.C.

F. T. Wahlen, Ottawa, Ont.; E. W. White, Victoria, B.C.; J. J. Woods, Agassiz, B.C.

1928 Convention

Mr. L. P. Roy, on behalf of the Province of Quebec, extended an invitation from the Deputy Minister of Agriculture, to hold the 1928 Convention in Quebec City. This invitation was very gratefully accepted.

Report of the General Secretary

Presented at the Seventh Annual Convention, C.S.T.A.
Vancouver, B.C., June 16, 1927.

By Fred H. Grindley

In presenting the seventh annual report of the Society, it is a pleasure for me to report another year of prosperity. During the past twelve months there has been an encouraging increase in membership, a condition of comparative wealth and an apparent improvement in the appearance of the magazine. Annual reports have now been given with sufficient frequency to compel a repeated account of what has become merely routine work, together with such observations as might suggest themselves from a close observation of the Society's affairs.

Membership

Let me deal first with the matter of membership. In this connection I regret to announce the loss of four members through death:—Mr. J. H. Piette who died in January, 1927; Mr. G. J. Jenkins, who died on February 22, 1927; Mr. R. H. Abraham who died on March 26, 1927, and Professor William Lochhead, a Fellow of the Society, who died on March 26, 1927.

It has been necessary to remove the names of 36 members, a few because of written resignations but the majority for continued non-payment of fees. During the year there were 129 applications for membership accepted. Most of those applications resulted from a membership campaign which was launched in September, 1926, sponsored by the President of the Society and maintained, with the co-operation of the local branches, for about four months.

On June 1st, 1926, the total membership (reported at the last Convention) was 911 (868 regular members and 43 student members) and on June 1st, 1927 the total membership was 1,000 (987 regular members and 13 student members). Of the present membership 90 per cent. were fully paid up on June 1st, 1927 and 10 per cent. were in arrears. No member, however, is more than one year in arrears.

It would appear that greater effort mig be directed toward the enrolment of stude members at the various agricultural colleg and universities. It is interesting to no that of the 43 student members who were our membership list a year ago, 27 have be come regular members. It is also worthy record that of the other 89 applications f regular membership, 40 were from form members of the Society.

It is quite safe to assume that our prese membership can be maintained, but sin there are always a certain number of res nations and delinquent members during t year, a fairly extensive membership campai should be undertaken each year, in ord that the Society may always command t attention of those eligible for membership.

There have been noticeable increases membership in Alberta, British Columb Manitoba and Ontario, and only slight creases in New Brunswick and Saskatchew

The present disrtibution of membership as follows:—Alberta, 109; British Columb 75; Manitoba, 80; New Brunswick, 30; No Scotia, 33; Eastern Ontario, 123; Nor western Ontario, 9; Western Ontario, 1 Niagara Peninsula, 29; Prince Edward Isla 12; Macdonald, 60; Montreal, 84; Queb 58; Ste. Anne de la Pocatière, 35; No Saskatchewan, 48; South Saskatchewan, 4 British & Foreign, 36.

"Scientific Agriculture"

The official organ has been published w reasonable promptness, about the first each month. An effort has been made increase the number of pages, in order take care of the fairly numerous lengthy a cles submitted for publication, and the c rent volume will be approximately 50 pa thicker than the preceding one. The qual of paper in the magazine has also been proved and is much more suitable for reproduction of illustrations than the pa formerly used.

Most of the articles published have been fairly technical and very few could be considered popular. This tendency does not, of course, meet with popular approval among certain classes of the membership body, but it is quite apparent that the policy of making *Scientific Agriculture* a fairly technical journal is the policy expected of the Society in scientific circles. At present it is too undignified in appearance to command the full respect and recognition of abstracting journal and institutional libraries and in view of the recognition which would result from a change in the present make-up of the magazine with little immediate change being necessary in the type of articles published, some careful consideration might well be given to this matter.

As mentioned in previous reports, there are now a large number of scientific journals being exchanged with *Scientific Agriculture,* many of them in foreign languages. The number of exchanges continues to increase steadily. In order that some of these may be preserved for reference purposes, several volumes of the following journals have been bound during the past year:—

Journal of Agricultural Research
Review of Applied Mycology
Annals of the Missouri Botanical Garden
Experiment Station Record
Philippine Journal of Science
Journal of Heredity
Science
American Journal of Botany
Soil Science
Review of Applied Entomology

Bureau of Records and Employment

Some reference should be made to the Bureau of Records and Employment, for the organization of which the Chilean Nitrate Committee donated $1,000.00 during the calendar year 1926. During the past year an attempt was made to complete the collection, filing and indexing of records, but it is quite apparent that a number of members are not interested, and that a few are perhaps too interested. The information now available in the Bureau is reasonably complete and has already been used by several employers to their advantage. It is necessary, however, that some publicity should soon be given to the establishment of the Bureau if it is to functioin properly, and that some Committee or Board, preferably at Ottawa, should be appointed and be responsible for answering any enquiries which call for definite recommendations for existing vacancies. If such a committee were appointed, and some dignified publicity were given to the Bureau, there is no doubt that in a comparatively short time it could serve a very useful purpose.

Text Book Club

The sales of agricultural books through the Text Book Club have been fairly extensive and this feature of the Society's work is appreciated by a great many members. It is of course patronized partiicularly during the fall and winter months, largely by graduate students, and is practically idle during the summer.

Travelling

During the year your General Secretary visited the local branches in Nova Scotia, New Brunswick, Quebec City, Montreal, Eastern Ontario, Western Ontario and the Niagara Peninsula. At the meetings at Montreal and Quebec he was accompanied by the President of the Society. Fairly extensive travelling has been necessary, in Ontario and Quebec, in connection with advertising.

Finances

And now I come to the vital question of finances. A copy of the financial statement is in your hands.* At first glance it would appear that we have turned a credit balance of $1,546.50 into one of $2,739.48, a net increase of $1,192.98. You will notice, however, that during the year we have received two donations from the Chilean Nitrate Committee amounting to $1,183.34. ($583.34 is the balance of the $1000.00 grant for the Employment Bureau and the other $600.00 has been given primarily to assist in defraying the expenses of Maritime Province delegates to the Vancouver Convention, but if not entirely used for that purpose, the balance is to be spent in accordance with the wishes of the Dominion Executive.) These grants may

*A copy of the financial statement for the year ending May 31st, 1927, may be obtained on application to the General Secretary.

not be considered as normal revenue, and only $250.00 of the total revenue from this source has been used during the past year. Our actual increase in credit balance over last year is $259.64.

There are certain features, however, to which your attention should be drawn. In the first place, the reduction in annual fees from $6.00 to $5.00 reduced our revenue from this source very seriously. Further than that, there were a fairly large number of members who paid only a fraction of $5.00 in order to bring their paid-up membership to a uniform date (June 1, 1927) which has been established to simplify the payment of all fees. It is a great satisfaction to know that the Society has been able to finance on the $5.00 fee, but it is quite apparent that no further reduction in fees should be contemplated, and that no new expenditures should be incurred without very careful consideration.

As compared with the previous year, there have been slight increases in the revenue from renewal fees (due to a much larger number of members paying the smaller fee), from subscriptions and from advertising. Expenditures were increased for printing the magazine, for miscellaneous printing, for office supplies (due to binding of magazines) and for cuts. There were decreases in revenue from membership applications, and in expenditures for travelling and for clerical assistance.

It is quite plain that the Society is very greatly dependent upon advertising revenue, and after seven years it is perhaps safe to consider that an annual revenue of about $5,000.00 can be expected from this source. It is perhaps not generally known that a vast amount of time is required to produce this revenue and that other work has to be either neglected or performed inefficiently. However, under existing conditions it seems necessary to continue to depend upon our advertising, and if any permanent clerical assistance is to be employed, the funds must come from a further increase in advertising revenue. There is no other alternative.

It is unfortunate that the Society cannot build up a reserve fund, the interest from which could be used to increase current revenue. There are many ways in which more money could be used to advantage. Several of the local branches are finding it difficult to secure the attendance of their outside members at meetings, and if something could be done to finance part of their travelling expenses it would assist in maintaining their interest in the organization. Funds are needed to encourage the attendance of official delegates at the Dominion Conventions, and even if only the expenses of local branch secretaries could be partly paid in this way, it would serve as a means of recognizing the work which these secretaries do during the year. The size of the magazine could be increased and its quality improved. These requirements, I think, should be given preference before the matter of clerical assistance at headquarters is considered.

The Seventh Annual Convention

Plans for the Seventh Annual Convention were started at the time of the annual Convention of the British Columbia local in March, 1927. Various committees were then appointed and practically all of the organization work has been done by the Chairmen and members of these committees and the Executive of the British Columbia local branch. Grateful acknowledgment is also due to the Dominion Department of Agriculture, the British Columbia Department of Agriculture, the University of British Columbia, the members of the British Columbia local and the City of Vancouver for complimentary luncheons or banquets to the members. Special mention should be made of the assistance given by the Dominion Department of Agriculture in making possible the series of lectures included in the programme.

New Officers

Ballots for the annual election of officers were mailed to all members on April 9th and were opened at Ottawa on April 30th. The following official results were announced in the May issue of "Scientific Agriculture":

President—L. P. Roy.

Vice-Presidents—E. S. Archibald and A. T. Charron.

Honorary Secretary—L. H. Newman.

Meetings of the Dominion Executive Committee were held at Ottawa on June 25th, 1926, and at Victoria on June 15th, 1927.

The Society was officially represented at the Annual Meeting of the American Association for the Advancement of Science by Mr. Arthur Gibson and at the Annual Meeting of the Royal Society of Canada by the General Secretary.

There is nothing more that should be reported to the members at this time. The past year has been an exceptionally successful one and the members have the satisfaction of knowing that their Society is financially sound and that there is no immediately possibility of increased fees or assessments. All we need is something of that spirit of co-operation about which nearly all of us do a little preaching. Nothing can do us more good now than the development of that spirit within the Society.

Book Review

PRINCIPLES OF SOIL MICROBIOLOGY. By Selman A. Waksman, Associate Professor of Soil Microbiology, Rutgers University, and Microbiologist of the New Jersey Agricultural Experiment Station. Williams and Wilkins Company, Baltimore, 1927, xxviii, pp. 897, pl. 19, fig. 82.

Most students of soil microbiology have long been aware of the urgent need of a really comprehensive work dealing with the soil population, and the timely appearance of this volume from the pen of an outstanding soil biologist will be greeted with universal satisfaction.

The author has subdivided the material in the volume, which contains in all 32 chapters into four main headings: (a) occurrence and differentiation of microorganisms in the soil; (b) isolation, identification and cultivation of soil microoganisms; (c) chemical activities of microorganisms; (d) soil microbiological processes and soil fertility. The result is an exceedingly well conceived and carefully executed work in which the author has eminently succeeded in assembling, co-relating and presenting with a surprising absence of bias the known facts concerning the soil microorganisms and their activities.

In this work of nearly 900 pages the author has maintained a balance unusual in works of such a scope, and appears to have been successful in giving to each phase of his many-sided subject a just allotment of space. Each group of soil organisms is thoroughly treated; soil actinomyces, fungi, algae, protozoa and the non-protozoan fauna of the soil all receiving adequate emphasis in addition to that given the soil bacteria proper. The chapters dealing with the biochemical aspects of the activities of the soil microorganisms are particularly worthy of note, and present for the first time under one cover a comprehensive account of a phase of the subject which will be more and more emphasized in the future.

The book is particularly valuable for its references to soil microbiological and biochemical literature of which it contains over 2500, embracing practically every important contribution to the subject up to the time of writing. Particular mention may be made of the inclusion of references to publications appearing in Russian, which are unfortunately all too inaccessible to the majority of scientists in English-speaking countries. Furthermore, the book is well supplied with text illustrations in the form of graphs, tables, etc., and contains, in addition, a series of well chosen plates. Finally, a list of reference books on soil and allied sciences and well arranged subject and author indices complete a work which shows all the signs of painstaking preparation and careful compilation by the author and thorough cooperation on the part of the publishers.

To students of soil biology and biochemistry this outstanding work will be found to be quite indispensable. Moreover, all students of soil science, and microbiologists in general will find in this book an invaluable reference work and aid to a better understanding of general soil and biological phenomena.

A. Grant Lochhead.

Presidential Address.

Presented at the Seventh Annual Convention of the C.S.T.A.

By G. C. CREELMAN

Beamsville, Ont.

I want to be perfectly frank at the outset by admitting that this address has given me a good deal of concern. There were several forms which it might have taken. It might have dealt with the development of professional agriculture in the past forty years. That would have been interesting. It might have outlined some of the needs in connection with agricultural education. That ought to be instructive. It might have been a plea for agricultural research. That would have been timely. But, after all, I am talking as the retiring President of an organization of which you are all members. It is a young Society, only now completing its seventh year. Its growth and development, its prestige and influence, are in our hands. It is only now coming out of the danger period through which all new organizations are bound to pass and it is in sight of its real objectives. In other words, it has reached the turning point and the swing of the pendulum has already started in the right direction.

I decided, therefore, to talk about ourselves, to tell you what I think of the Society and its future, to make a few suggestions and then to sit down as an individual member and practice what I have preached.

The C.S.T.A. was needed when it was organized and it is needed more than ever now. It is filling a place in Canadian agriculture. Those who are inclined to be skeptical would be the first to clamour for such a Society if it ceased to exist. It has brought about a greater spirit of friendliness and co-operation among professional men than ever existed. It is perfectly organized from one end of the Dominion to the other. Local meetings are being held somewhere almost every week. Its Conventions have alternated from east to west each year and now have reached to the Pacific Coast. It has its own magazine, not only self-supporting, but bearing much of the Society's financial burden and keeping the fees down to a ridiculously low figure. It has one thousand members, an objective which a few years ago was considered quite beyond our reach.

These accomplishments, and others which I need not mention, have come slowly. Organization takes time, a fact which has been a stumbling block to the C.S.T.A. because many of its original members, lacking faith, have dropped out. But the C.S.T.A. should have no place for the faithless and resignations are not always weakening. I venture to say that we have not only increased our membership each year, which you all know to be true, but that the morale of the Society has been improved by the natural "weeding out" which has taken place. In other words we want boosters, not knockers, and in future I think that less effort should be spent on membership campaigns and more on the consolidation of those who have shown faith.

Let me tell you a few of the things which, in my humble judgment, the Society needs. Unfortunately none of us ever gets all he needs. Nevertheless I consider these things to be essential to future progress.

First, we need capital. That may come in time but up to the present every increase in our credit balance has been devoted to a lowering of fees—a mistake, I think, but one for which the General Secretary can blame himself. We must look ahead. We should be incorporated. We should be prepared for financial emergencies. I am assured by the General Secretary that an advertising slump would bankrupt the Society in three months.

Where are we going to get capital? I do not think we will ever get it from our present membership fee nor from advertising revenue, because if we produce profits from either of these sources they can be used to better advantage in other ways, which I propose to point out. To produce capital I suggest that the Society introduce a life membership, with a fee of $100.00, payable on easy terms if necessary. Let me explain more fully. Life membership fees could be set aside, invested to produce interest at least equal to the present annual fee, and safe-guarded as to prin-

ipal. Every life member could be given guarantee that, should the Society fail with- twenty years, his life membership fee ould be refunded in full. At the end of venty years, or on the death of a life mem- er, his principal could be turned into cur- ent account if necessary. My own opinion that this reserve fund would never be ouched in any way, but in course of time e interest from it would steadily increase ır current revenue. The details of such a heme could be easily worked out. There ould be nothing compulsory about life embership. I would be satisfied if we had fty life members a year from now. But is a scheme which would help to safeguard ır future and would at the same time give me of our members an opportunity to ake a permanent contribution to the Soc- ty.

The second need of the Society is an ade- ıate headquarters. We pride ourselves, or ıght to, on our profession. We want to mand public recognition. Then it seems me that we ought to have a respectable ead Office, with sufficient clerical assistance relieve the General Secretary of a lot of e routine work which he is now doing. The penses for these added facilities would ive to come from current revenue. I am clined to think that the increased volume work that could be done under the pro- osed conditions, as well as the added ef- iency of the central office, would result in fficient new revenue to justify the expendi- re. That, however, is a matter for consid- ation. The fact is undeniable that if the S.T.A. is to hold the place in Canada which want it to hold, and if it is to command ıblic attention and respect, then the present adquarters are entirely inadequate.

The third and last requisite, at least the st to which I intend to refer, is member- ip support. This, I know, is a very abstract ıality and one which it is difficult to ex- ain. With a membership of one thousand is hard to hold the interest of all, and rticularly of those who are unable to at- ıd local or Dominion meetings, or those whom a fee of even five dollars is a ser- us item of expenditure, or those who find tle to interest them in the magazine. But am very sincere when I say that all classes of membership must give their support to the Society. Surely every agricultural grad- uate has some pride in his profession; if he hasn't he should choose some other voca- tion. The C.S.T.A. is your Society; you are its strength; in you the destiny of the Soc- iety rests. We must get behind it in a body in every way we can—by attending meetings when possible, by contributing to the maga- zine and reading it, by offering constructive criticism, by enrolling new members and pay- ing our own fees promptly. In other words we must create a C.S.T.A. spirit and see that that spirit is spread like the Gospel.

Given the three requisites that I have named —capital, headquarters and membership sup- port—nothing can stop us. I leave that thought with you now.

May I add a word about the future place of the Society in Canada? I have tried to be unbiased in forming my opinions. I think I have been long enough in professional work and in public life not to associate myself with any organization in which I see no future. I have had faith in the C.S.T.A. since it started but my faith is stronger to- day than it was over seven years ago when, as President of the O.A.C., I was asked to express an opinion as to its organization.

The C.S.T.A. can do much for professional agriculture in Canada, much for agricultural education and research, much for its mem- bers. It is gaining recognition rapidly, its various committees are doing useful work, its magazine is known throughout the world in scientific circles. It has a standing in Can- ada and elsewhere. It is a credit to all of us. I see the day, not far distant, when C.S.T.A. counsel will be sought upon many matters, when the annual meetings will bring together groups of men who will meet—as groups—in a series of concurrent programmes, and in a body for social events and business sessions. I see it prosperous, with- out any of the handicaps against which it has had to struggle in these early years. I see it receiving credit, long past due, for a new era in professional agriculture and for a bet- ter spirit among the workers. The picture cannot well be overcharged.

In closing I want to thank every member for the honour they conferred upon me in

electing me as President last year. May I thank especially the members of the Dominion Executiive, the local branch executives and the members of standing committees, all of whom have done a great deal during th year. I intend to remain an active membe

My last word is—have faith in the Societ —your Society—and in its future.

Report of the Chairman of the Committee on Educational Policies.*

Your Committee beg to present the following report:

In the report of the Committee on Educational Policies which was adopted at the sixth Annual Convention of the Society at Ottawa in June of last year, the following recommendation appears:

> "Your Committee strongly recommends that steps be taken by this convention, through the appointment of a small com,-mittee, or otherwise, to ensure that such recommendations as are approved by this convention, be brought to the attention of the Department of Education and the Department of Agriculture in each of the provinces, to the Dominion Department of Agriculture, and to the agricultural colleges and faculties of agriculture in Canada."

Immediately following the convention, the Dominion Executive of the Society appointed the undersigned a special committee of one to visit each of the provinces in order to carry out the wishes of the convention as expressed in the above recommendation. This commission has been carried out to the best of my ability. All the provinces have been visited and the more important findings of the Committee on Educational Policies, as adopted by the convention, have been discussed in detail with responsible officials of the Department of Education and of the Department of Agriculture in each of the provinces, with the exception of the Department of Education in the Province of Manitoba.

Since a representative of at least one university or of one college of agriculture in each province was a member of the Committee on Educational Policies which reported to the 1926 convention, and since the views of these members and the views of the institutions which they represent have bee considered carefully, annually, for the pas four years, and since the recommendations o this representative Committee were adopte by the convention without amendment, you special committee did not consider it neces sary to lay, in person, the findings of th convention before the colleges of agricul ture or the faculties of agriculture. Similar ly, and for much the same reason, the spec ial committee did not consider it necessary t present, in person, the findings to the Dom inion Department of Agriculture.

In order that all interested might be mad acquainted with the recommendations a adopted, the General Secretary had copies o the report of the Standing Committee o Educational Policies printed for distributio to all who were interested. These proved mos valuable in many ways, but especially whe a personal interview had been arranged With printed copies of the report in the hand of each official on whom your committe called, the way was prepared for a carefu consideration of the main issues without mak ing undue demands upon the time of th Ministers or of their deputies. Although th season of the year was not the most favour able for seeing government officials, still, wit but a single exception, both of the depart ments of government most directly concerne were seen in each of the provinces. This ex ception was in the case of the Department o Education in Manitoba. The responsibilit for this failure, however, rests with the com mittee and not with the officials of the De partment.

In attempting to state the impressions gath ered in these interviews, your committee i surprised, not that there was lacking com

*Adopted at the Seventh Annual Convention o the C.S.T.A. at Vancouver, B.C., June 17th, 1927

plete unanimity on certain of the recommendations, but rather that the conflict of opinion was not more pronounced and that it did not manifest itself on more occasions than it did. Conditions in the different provinces are so diverse, and the demands which are made upon the colleges and faculties of agriculture are so varied and so inconstant that it would be remarkable indeed if personal opinion and educational policy in one province did not differ markedly from those in another part of the Dominion. Because of this diversity of opinion, the observations made by your committee, while carrying out the instructions of the Dominion Executive, confirm the wisdom of the course adopted by the Standing Committee on Educational Policies when it decided to confine the discussion as closely as possible to the consideration of fundamental questions of educational policy.

Prince Edward Island

In this province, prospects for the immediate development of agricultural education are not alluring. The officials, while interested in certain phases of the report, were perplexed and well nigh discouraged. The attitude of the public towards the one-time consolidated schools of the province, together with the enforced closing of the combined Agricultural and Technical School, has had a depressing effect. Under these circumstances it is not to be wondered at that the findings of the Committee were of little more than academic interest to the educational authorities.

Nova Scotia

Here, the Department of Education is interested primarily in that part of the report which deals with agricultural education in the public and in the high schools. At the Agricultural College at Truro, changing conditions in the province have created new avenues through which the staff is rendering direct and increasingly valuable service to the farming community. These new opportunities have necessitated the adoption of new angles of approach, a shifting in emphasis, and in some instances, far-reaching changes in educational policy. During the past few years genuine enthusiasm has been developed for the three months' winter course at the College and for the extended short courses in different parts of the province. It is perhaps too early to form an opinion as to the probable effects which these developments will have on attendance at the more extended courses given at Truro.

New Brunswick

It would appear that the cause of agricultural education in New Brunswick will continue to suffer reverses and make little or no permanent progress until such time as the authorities agree upon a sound, progressive policy, based, in its essential features, upon the recognized principles which underly successful systems elsewhere.

Quebec

In no province did your Committee find a keener interest in the findings of the convention, or a more appreciative understanding of the import of the recommendations, than was manifested in Quebec. The attitude of the Department of Agriculture was no less sympathetic than was that of the colleges, whether French-speaking or English-speaking. The justifiable pride which the educational authorities showed in their present attainments was tempered by a healthy dissatisfaction and by an earnest desire to learn the most recent developments in agricultural education in each of the other provinces in Canada. In Quebec, when the value of the old has been abundantly demonstrated, there is no disposition to make adjustments; but when the promise of improvement presents itself the authorities are not slow to make departures from accepted practice as recent experiments in agricultural education attest.

Ontario

In this province, the representatives of the University and of the Department of Education with whom your committee conferred were favourable, in the main, to the recommendations which relate to the agricultural colleges. They heartily approved of the recommendations regarding graduate work, but seemed to think of them, primarily, in terms of the University and not of the faculty at the Ontario Agricultural College. The representative of the Department of Agriculture

was not inclined to look with favour on some of the recommendations and was still less disposed to approve of others. He pointed out that admirable as these recommendations might be for some of the provinces, there was little probabilitiy that they would be adopted in Ontario in the near future. The general attitude seemed to be: For others these recommendations may be good. Who shall say?

Manitoba

In the Department of Agriculture, the opinion was expressed that the recommendations regarding the status of agriculture in the public school curriculum was one to which exception would be taken in certain quarters. This opinion had previously been expressed by members of the staff of the Manitoba Agricultural College and by a number of the delegates to the Edmonton Convention. It appears that many farmers in Manitoba, far from desiring to have the teaching of elementary agriculture made compulsory in the higher grades of the public school, do not wish their children to be taught agriculture either for its educational or for its vocational value.

Saskatchewan

In Saskatchewan, the University, the Department of Education and the Department of Agriculture are in full accord with every major recommendation contained in the report.

Alberta

Here, the University and the Department of Education are in almost complete agreement on all the more important findings. The fact that the agricultural schools in the province come under the Department of Agriculture, not under the Department of Education, quite naturally makes it impossible that all the recommendations of the committee should meet with the unreserved approval of the officials in the Department of Agriculture.

British Columbia

Next to Saskatchewan, British Columbia probably finds itself in fuller accord with the recommendations of the committee than does any other province. And yet the teaching of agriculture in the public and high schools of this province has been seriously curtailed within recent years. This curtailment is one of the direct results of the decision of the Dominion Government to discontinue the policy of granting financial assistance to the provinces for this purpose. Unfortunately the experience of British Columbia in this respect has been closely paralleled by that of many of the other provinces in Canada.

In every province the reception given your committee was most cordial, and the interest in the findings, almost without exception, was keen. The recognition which is being accorded the Society in every province in the Dominion is most gratifying. Seven years ago, to all but the most sanguine, such recognition would have been regarded as beyond the possibility of attainment in less than a generation. Thus does the Society continue abundantly to justify its organization.

(Signed) L. S. Klinck.

Report of the Committee on Marketing Education.

Mr. A. A. MacMillan, Chairman of the Committee, was unable to attend the Convention. Dean F. M. Clement was the only member of the Committee present and he reported verbally for the Committee. No full meeting was held during the year but considerable information was collected by the Chairman through correspondence.

A telegram was received from the Chairman recommending that the Convention take into consideration the possibility of holding a special course of two or three weeks' duration on Marketing Education, such courses to be held alternately in eastern and western Canada. A resolution was passed by the Convention recommending that the Executive take into consideration the matter of special courses.

Dean Clement, when speaking to the resolution, said that marketing education might be divided into two parts. First, there was the general descriptive work, that is, work which describes in detail the distribution of some product step by step from the farmer to the

consumer. Second, there was the general understanding and appreciation of the marketing problem which should be given further consideration. A superstructure had been reared on and above agriculture and so far this superstructure had not been given special study. The Committee might devote further time to the study of what is being done in Canada by the Dominion Government and the various provinces in relation to marketing demand, competition, price, the share of the consumer's dollar that is finally returned to the farmer, and similar matters. It should be the object of marketing education to give the farming and general public as clear a conception of the marketing problem as we now have of the primary production problem.

Genetics and Breeding.*

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Genetics has been defined as the science which seeks to account for the resemblances and differences among organisms related by descent.

It deals with the mechanism by which resemblance between parent and offspring is conserved and transmitted, with heredity, and with the origin and significance of variation. These two things, heredity and variation, are also of primary concern to the breeder.

Despite this unity of interest, the usefulness of the geneticist to the breeder has sometimes been challenged in the contention that the varieties of plants and animals, as well as the methods of their production, are the results of practical breeders who knew little of theoretical genetics.

It is true that genetic experimentation has utilized such non-essential characters as color of flowers, color or shape of seed in plants, and color of hair or skin, shape of comb, etc., in animals rather than differences of such important economic characters as early maturity, high production, resistance to disease and edible qualities in plants and animals.

The first aim of genetic experimentation is to furnish exact knowledge concerning heredity. It has made use of the non-essential characters because they lend themselves most readily to our exact study. It is only after the knowledge has been gained from these minor characters that the inheritance of the more complex economic characters can be undertaken.

The contributions of genetics have not been in the form of new varieties or breeds but in the explanation of observed phenomena and interpretation of practical methods and results, so that the breeder is able to discard all unessential steps in his practice and proceed with more confidence toward his goal.

Practical breeding operations over a long period of time have led to the formulation of effective methods of breeding but have contributed little toward understanding the results which have been achieved. Genetic experimentation on the other hand, is concerned primarily with explanation and interpretation and has solved many perplexing problems which have arisen in plant and animal breeding. Such matters as reversion, criss-cross inheritance, prepotence, maternal impressions, inbreeding, telegony, nicking and sex control have all been logically explained and no longer have a mysterious or baleful meaning.

Influence of Genetics on Selection.

Breeding methods have always rested and probably always will rest upon selection. Genetics has contributed very materially to an understanding of the effectiveness of selection.

Johannsen was the first to demonstrate clearly that variations were of two kinds as regards effectiveness of selection—hereditary

*Lecture delivered at the Seventh Annual Convention of the C.S.T.A., Vancouver, B.C., June, 1927.

On the left *Crepis biennis* 2N=40 On the right *Crepis setosa* 2N= 8

In the center a new form derived from a cross between these two species. The new form has 2N=24. The chromosomes of the two species are from camera lucida drawings, those of the new form a photomicrograph.

and environmental. He also demonstrated that crops which were naturally self-fertilized existed as a mixture of pure strains and that a single selection of individual plants was effective in separating the strains.

In 1896, four years before the rediscovery of Mendelism, an experiment was started in Illinois to test the effect of selection for chemical composition in corn, using the empirical method of "selecting from the best". The experiment was continued for 23 years in four directions:

1. High oil content.
2. Low oil content.
3. High protein content.
4. Low protein content.

There was a positive result in all four lines of selection. Starting with corn which contained about 11% protein, after 23 years of constant selection a strain was secured which had about 15.5% protein.

In the meanwhile genetic experiments demonstrated that constant selection in a given direction had no creative effect whatever, but merely sorted certain designated types out of a mixture of forms, that the effectiveness of selection ceased when all the individuals of a strain were genetically homozygous. This was contrary to previous ideas concerning selection. It also was shown that inbreeding quickly reduced a heterozygous group of individuals to a mixture of pure lines or genetically homozygous groups.

East decided to apply this newly acquired knowledge concerning selection to the problem of producing a high protein strain of corn. By combining selection with inbreeding he was able to better than duplicate in five years the results of the Illinois experiment which had extended for twenty-three years.

Not all of the inbred strains reached the same upper limit which indicated that the parent plants of the different lines differed genetically.

The principal influence of genetics upon selection has been to shift the attention in selection from the phenotype, that is visible, to a consideration of the genotype or the ability to traansmit visible characters to progeny.

An excellent demonstration of the relative merits of the old empirical phenotypic methods of selection and selection based on a knowledge of the genotype is found in the selection for high egg production by Pearl at Maine.

During a first period of 8 years (1899-1908) a system of mass selection was employed. Hens showing a record of 1504 eggs for their first year were placed together in the breeding pens with males from 200 egg mothers. This method failed to produce a flock of higher producers. At the beginning of the second period (1908-1915) a genotypic method of selection was introduced. Selection of breeding birds was not based directly upon the egg-laying ability of an individual, but upon the egg-laying ability of all the female offspring of each hen. The males were chosen from mothers, all of whose female progeny were high producers.

The selection on the basis of ability to transmit high egg production was entirely and immediately successful.

The two methods, however, differ not so much in the ultimate results, but only in the speed with which the results are obtained as is clearly shown in the selection for high protein in corn.

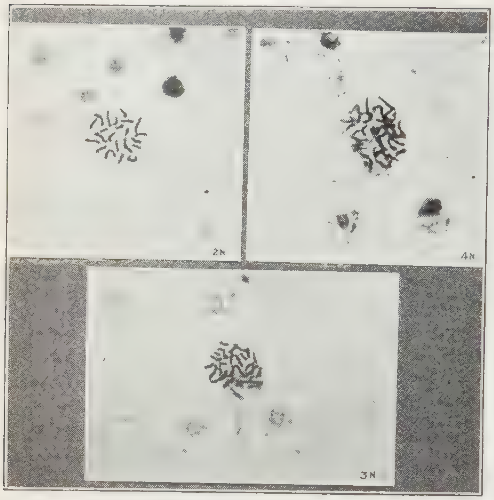
Genetic Analysis of Species.

The service of genetics to breeding in the future will be in supplying a genetic analysis of the important agricultural species. Genetics is primarily concerned with analysis of organic forms; it attempts to study the separate hereditary units of which an organism is composed. Breeding on the other hand, is primarily concerned with synthesis, or the combination of characters of different individuals into a single new type. Breeding can therefore use the information concerning these characters supplied by genetics.

The most extensive genetic analysis of any species has been made with *Drosophila melanogaster*, a small fruit fly. While it is of no economic importance it serves as an illustration of the method and possibilities of species analysis.

This dipteran with its prolific breeding habits, short life cycle, (a generation every 14 days) and ease of handling has shown itself a form far superior to any other thus far found for unravelling of the problems of heredity. Geneticists have taken advantage of this splendid material and have formulated what is known as the chromosome theory of heredity, according to which *the chromosomes within the cells form the material basis of heredity and upon these, each in its own particular constant locus in a particular chromosome are situated the genes, the activity of which determines the expression of the corresponding characters during development of an individual.* This theory is based upon the results of countless breeding evperiments involving millions of individuals.

These studies besides giving us a workable theory based upon controlled pedigreed material, have given us more definite information concerning the occurrence of mutations, the stability of the gene, the effects of selection, sex-linked inheritance and the multiple ac-



Chromosomes in Crepis. The upper left figure (2N) is the diploid number 24, from the root tips of the normal form. The figure at upper right (4N) is a cell from a tetraploid sector or island in the root of the same plant. The lower figure (3N) is a cell from a triploid plant belonging to the same population with the above 24 chromosome plant.

tion of genes. *These are attributes of living organisms*, and Drosophila has no patent upon them. The results of breeding experiments with these insects have profoundly influenced the outlook in plant and animal breeding.

Over 500 characters have been studied in this fly. They have been found to fall into 44 linkage groups, one group for each pair of chromosomes. Characters belonging to different groups show independent assortment when crossed, but members of the same group show linkage relations. Maps of the chromosomes showing the relative arrangement of the hereditary genes causing the development of the known characters have been constructed from results of breeding experiments.

No longer can it be maintained that genetics deals with superficial and trivial characters, for some of the characters which have been analyzed in both plants and animals may so seriously interfere with the normal physiological processes as to cause the death of the individual receiving it. With the knowledge of the mode of inheritance for a large number of characters available, as it is in Drosophila, it is possible to synthesize almost any desired compatible combination of characters.

The advancement of genetic studies in corn stands out above all others in the plant kingdom. Partial maps of 8 pairs of chromosomes out of a possible 10 have been started and the inheritance of over 100 characters has been studied. In the future as additional knowledge of heredity in this species accumulates, it may be possible to locate those hitherto elusive factors, which control the development of those characters which make a superior plant. Such characters as yield, resistance to drouth, and to insect or fungus attacks, are frequently due to the combined action of a number of hereditary genes. We have reason to believe that they are definite hereditary units, located in definite parts of the chromosomes just as are the genes for the characters which have already been studied.

Already plans are under way for utilizing the rapidly increasing genetic knowledge in corn and in wheat.

By inbreeding in a number of varieties of corn, there have been secured a larger number of homozygous strains, each differing from others in some respects. Strains have their ability to obtain inorganic food materials from the soil; strains that differ in their rates of growth, in their resistance to drouth and in their resistance to various diseases.

When a more complete genetic analysis of these character differences is available we will know how to combine these strains to secure greatly improved varieties, or how to transfer a character from one strain into another. It is common experience that one inbred line may be superior in regard to one character but weak in another; another line may be just the reverse, still other lines may be notable for a large thrifty root system.

With genetic information concerning these characters available it will then be possible to incorporate these desirable traits from a number of foundation lines into one true breeding super-variety.

This idea is already being put to the test on a smaller scale in wheat breeding. It has been found that wheat stem rust exists in a large number (37) of genetically distinct forms. The different forms do not all attack wheat varieties with the same degree of severity, but most varieties of wheat are susceptible to the serious attacks of a number of forms. Some varieties of wheat show resis-

tance to a rust to which other varieties are susceptible.

Due to the migration of rust forms it is desirable to have wheat varieties which are resistant to all forms of rust. Genetic experiments at Minnesota and elsewhere have shown that it is possible to transfer the resistance to a particular rust from a resistant variety to one which was susceptible.

We have reason to hope, therefore, that in time it will be possible to secure strains of wheat resistant to many, if not all, of the 37 known forms of stem rust.

Bridge at the California station has studied the genetics of resistance to smut in two varieties of common wheat, Martin and Hussar, both of which are completely resistant, but are undesirable as wheat varieties. During a period covering about 5 years he worked with but one object in view—to determine the method of inheritance of the resistance which was found in these two varieties. Afterward attention was turned to the problem of introducing this resistance into commercial varieties and it was found to be a comparatively simple matter. Within a period of 3 years he has produced forms which duplicate standard commercial varieties in every respect but they show complete resistance to bunt.

Breeding is being largely resorted to in the hope of producing varieties of plants which will not be subject to injury by disease producing organisms. The relation of breeding to the sugar beet industry in California is a notable example of the value of genetic investigations.

Sugar beets had been grown upon thousands of acres and an industry profitable to the farmer and refiner alike had been developed. Then a disease, Curly top, began to be noticed. Each year it became more and more severe until now the industry is almost completely abandoned. Thousands of dollars were spent in trying to control the disease but no practicable and efficient method was found. In desperation breeding for resistant plants, as the only hope to save the industry, was begun by the U.S. Department of Agriculture, California Experiment Station and by the Spreckles Sugar Company. They have succeeded in finding strains which appear fairly resistant to the Curly top, one of which is high enough in sugar content to be useful.

Utilization of Hybrid Vigor.

It has long been known to students of heredity that crossing of two distinct strains or species often causes a marked increase in vigor, rapidity of growth and early maturity. This phenomenon has come to be known as hybrid vigor.

This hybrid vigor has been used unconciously in the development of vigorous, hardy productive varieties of fruits and ornamentals, but only comparatively recently have attempts been made to utilize this increased vigor in the production of field crops. The effects of crossing are most pronounced in the F_1 generation and are rapidly lost in successive generations. A theory based upon linkage of multiple genes has been advanced to account for this fact, but I shall not tire you with its detaiils. The important thing to know is that the vigorous, productive F_1 individuals do not make good parents and should not be used for prolonging a new crop.

Experiments are now under way in a number of places in the corn belt area to determine the practicability of utilizing hybrid vigor in corn production.

The procedure consists of selfing several varieties of corn for 5 or 6 generations which results in the elimination of hereditary weak or sterile individuals, leaving in the end only the most vigorous and fertile of the original strains in the varieties selected. These inbred strains are then grown in isolated places and continued as parent varieties. A crossing plot for the production of F_1 hybrid seed must be grown each year in which the two parent inbred strains are planted in alternate rows. The tassels of all of one variety are removed before the pollen is ripe, so that all ears of corn produced upon the detasseled rows will be wind-pollinated from the other variety. The corn from the detasseled rows furnishes the seed for field planting. The corn from the non-detasseled rows is selfed and pure for that strain. By collecting enough seed from these rows for planting in the seed plot for two successive years and by alternating the strain detasseled each year, it will be possible to carry this system on

without the necessity of planting two isolated plots to maintain the inbred strains.

Seed produced in this way will cost more than ordinary crib selected seed ears, but experiments have already indicated that the returns in increased yield will more than justify the additional expense and time required in producing the hybrid seed.

Another method of obtaining higher producing strains of corn has been suggested as a result of genetic studies on corn. All varieties of corn carry a large number of recessive characters which are detrimental to growth and development. They represent many weak, and sterile types which when present reduce the total yield of the crop.

The method which has been suggested is to inbreed one or more varieties for 5 or 6 years, during which time all of these weak types will come out as homozygous strains. In some cases they will be unable to perpetuate themselves and will be automatically eliminated; other weak or useless strains can be discarded, leaving only those few most hardy and vigorous strains, which can then be thrown together to produce a new field type, purged of all the weak and undesirable types, which will cause the general average of the crop to be appreciably increased.

Once such a purified variety is obtained no further breeding is necessary. The cost is low and the method simple enough to be successfully carried out on the farm.

Breeding and Forestry.

Genetic information is also being called upon to help solve problems in forestry. Klotzsch began crossing trees in Germany as early as 1845. He claimed that rapidity of growth and durability of timber cauld be increased by hybridization. But unfortunately his work was not followed up.

The possibilities of producing rapid growing, hardy timber trees was again emphasized by Burbank's publicity of species hybrids in walnuts.

Augustine Henry in Ireland, has produced F_1 species hybrids of a number of different kinds of trees and has found a marked superiority in vigor of growth of hybrids over parent species in many cases.

At Placerville, California, there has recently been established by James G. Eddy of Seattle, a tree breeding experiment station, which is dedicated to the develpoment of improved rapid growing strains of forest trees for use in reforestation in the West.

Little has as yet been accomplished in the way of producing superior hybrid trees on a large scale but enough to show that it is desirable to continue investigations.

Conclusion.

I have attempted to show the relationship existing between genetics as a science and the practice of breeding. It was pointed out that genetics is primarily concerned with the accumulation of knowledge regarding causes of certain natural phenomena. Breeding on the other hand, is concerned primarily with using the phenomena of heredity and variation in the production of superior strains of plants and animals.

Genetic analysis of species must precede the synthesis of new forms. It is evident that as additional genetic information is obtained the increasing pressure of economic conditions will demand its application to practical affairs.

Recent Experimental Genetics.*

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The rediscovery in 1900 of the method of analyzing problems of inheritance marks the beginning of genetics as an exact science. It is true that during the period preceding this date the problems of heredity and variation engaged the attention of many biologists but since they lacked the proper method of analysis they failed to observe any uniform laws. This period has been aptly characterized as one of speculation and of random experimentation.

The history of the development of genetics shows a gradual shift in the focal point around which investigation has centered.

1. At first attention was focused upon the contrasting characters of individuals. It was thus demonstrated that Mendelism was applicable to a wide range of organic forms.

2. The focus of investigations then focused and became centered around the gene, the germinal representative of a somatic character. These studies resulted in the formulation of additional laws of heredity, namely, (1) linear arrangement of the genes, (2) linkage of genes, (3) limitation of the linkage groups to the haploid number of chromosomes and (4) interference in crossing over between two closely adjacent genes of the linear series. Results indicate that these new laws are as universal in their application as are those formulated by Mendel.

3. The focus of genetic research is at the present time shifting from the gene to a study of the effects of altering the number of chromosomes, which represent linked groups of genes, either by the addition or subtraction of single chromosomes, or of whole sets of chromosomes or by the introduction of foreign chromosomes. It is this latter phase of genetic research, the effects of altering chromosome number, that I wish to consider more fully.

Variation in Chromosome Number in Related Species.

The number of chromosomes have been determined in something over 1,000 animal and 2,000 plant species. In animals the number has been found to extend from one pair in a species of Nematode to over 100 pairs in a species Decapod; in plants, from two pairs in a fungus to over 100 pairs in some ferns.

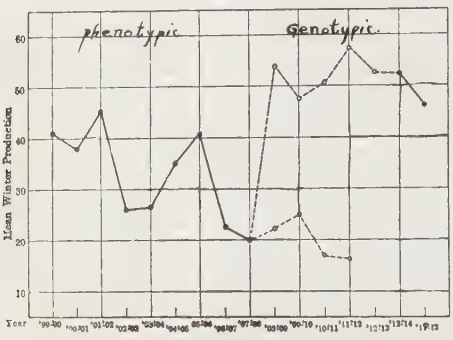
Regardless of the number, whether few or many, it remains constant for all the members of a given species, but different species of the same genus may vary greatly in chromosome numbers.

In some genera the species differ from each other in such a way that their chromosome numbers are multiples of some basic number which is the haploid or genetic number of the lowest member of the series. Thus in Triticum, there are wheat species having 14, 28 and 42 chromosomes, each a multiple of 7, which is the haploid number of the species with 14 chromosomes. Täckholm reported species of the rose with 7, 14, 21 and 28 haploid chromosomes. Other similar series of species are also known.

It is easy in such cases to consider the origin of these chromosome number differences as due to a doubling, trebling, quadrupling, etc., of the chromosomes of an original species. It is very probable that this is the correct cause in some cases at least.

In some species there have been found in somatic tissues small areas or islands of cells containing double the usual number of chromosomes, i.e., islands of tetraploid tissue in a normal diploid plant indicating that doubling of the chromosome number does take place. If such a tetraploid sector should involve the germinal layer some of the gametes would then come to have the double number, i.e., be diploid gametes. These gametes uniting at fertilization with normally haploid gametes would give rise to a triploid plant. Two diploid gametes uniting at fertilization would give rise to a tetraploid plant.

*Lecture delivered at the Seventh Annual Convention of the C.S.T.A., Vancouver, B.C., June, 1927.



Graphic representation of comparative results of two methods of selection. Mass selection for the period 1899 to 1907 failed to produce a flock of high producers. During the period 1908 to 1915 genotypic selection based upon progeny performance was followed and was immediately successful. (from Pearl).

Plants in which the number of chromosomes have been increased by one or more haploid sets have been reported in pedigreed cultures of Crepis, in Datura, in Primula and Oenothera.

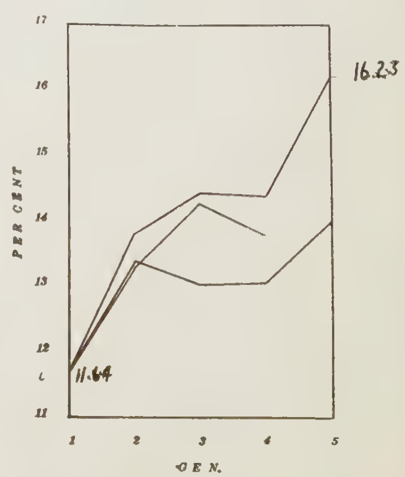
In almost all cases the most obvious effect of the increase of chromosomes by haploid sets is to produce gigantism.

While in some cases this is probably the correct intepretation of the origin of species with increased chromosome numbers, there are other cases of variation in chromosome numbers which obviously could not have arisen in this fashion. In other genera the chromosome numbers of the species do not show a common basic number. The Crepis genus is one of this sort where we find species with 3, 4, 5, 6, 8, 9, 20 and 44 pairs of chromosomes. In tobacco we find species with 9, 10, 12, 18 and 24 pairs of chromosomes. In Carex, six species may be selected with a fundamental haploid number 3. Another group of 7 species appear to have 4 as their basic number, while still others are multiples of seven. Additional evidence that such series have not resulted from a direct multiplication of a basic number is derived from a consideration of the size relations of the chromosomes. In a diploid form there are two of each kind of chromosome, in a true triploid there are three of each kind, in a tetraploid four of each kind, etc. In some of the polyploid forms such size relations do not exiist.

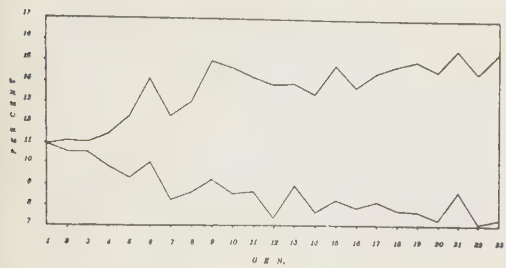
There may be methods operative in the production of variations in chromosome numbers. We may consider some of the results from studies of two additional methods, namely, non-disjunction and species hybridization.

In most organisms the diploid number of chromosomes is an even number. Rarely during the formation of gametes one member of a pair of chromosomes fails to separate from its homolog (a phenomenon known as non-disjunction), with the result that both are included in the same gamete, which then contains one chromosome more than the normal for gametes of that species. Upon fertilization with a normal gamete, a zygote containing one more than the diploid number is produced. Such a form is known as a trisomic. A mono-somic form is produced when its chromosome number is one less than the normal.

The addition of complete haploid sets of chromosomes tended to produce giant types. All the characters appeared to be affected rather uniformly. The addition or subtraction of one chromosome also affects the somatic characters but is often less general and more specific in its action. This indicates that a preponderance of the multiple genes for certain expression may be carried in one chromosome. The loss, or even the addition, of one chromosome is therefore often more serious to the genetic stability



Graphical representation of the effects of selection in self-fertilized lines over a period of 5 years. (after East and Jones).



Graphical representation of the gradual effects of mass selection in corn during a period of 23 years.

of the individual than the alteration in haploid sets.

If one chromosome carries a preponderance of genes of one type which alone may influence the development of characters preponderantly in one direction they are counterbalanced by a preponderance of the reverse type of genes in another chromosome, the two together strike a balance resulting in a normal individual. If one chromosome is removed or added this balance of genes is more seriously altered than when changes in haploid sets occur.

In the experimental cultures of tobacco at the University of California, one plant in a particular culture was found to have larger flowers than other plants of that culture, but it differed in no other respects. This larger flower size was found to be due to the presence of an extra chromosome, this plant having 40 instead of 48 chromosomes, and constituted what is now known as a trisomic plant.

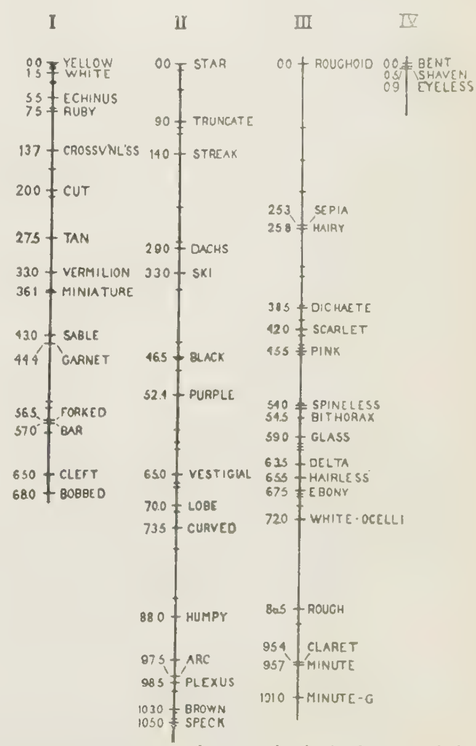
A series of trisomic types have also been found in *Datura stromonium* and in each case one or a few characters only show a distinct change.

A trisomic individual should produce 50% of its gametes having one extra chromosome. Two such gametes uniting at fertilization should theoretically result in a new type in which the chromosome number was increased by two chromosomes, or one additional pair. Both plants and insects of this type have been obtained, but in all cases they were unstable. The enlarged tobacco plant gave rise to some plants having flowers considerably larger than the flowers of enlarged plants. These super enlarged plants were found to have two extra chromosomes. The evidence at the present time seems unfavorable for the production of self-perpetuating types by the route of non-disjunction.

Species Hybridization.

Another way by which types with a new chromosome number may arise is by the crossing of species. Ljungdhal crossed a poppy, *Papaver nudicaule* (N=7) with *P. striatocarpum* (N=35). The hybrid had 42 chromosomes, the sum of the haploid numbers of the two parents. The hybrid is fertile and breeds true for the hybrid condition. The behavior of the chromosomes during germ cell formation is typical of a good species. The 42 chromosomes form 21 pairs, one member of each pair passing into a daughter nucleus at the first or reduction division during gametogenesis. A new type is thus produced.

Clauson has produced a new tobacco species from the interspecific cross, *N. tabacum* (N=24) x *N. glutinosa* (N=12) which gives a sterile F_1. In a culture of F_1 plants



Chromosome maps showing the loci of some of the hereditary genes in the four linkage groups of *Drosophila melanogaster*. (After Morgan).

a single plant was found to be partially fertile, from which an F_2 population was secured. The plants of the F_2 generation were uniform and similar to the F_1 but slightly larger. They were found to contain 72 chromosomes in their cells instead of 36, the number typical for the sterile F_1 hybrid. The gametes all contained 36 chromosomes.

The original F_1 fertile plant must have arisen from doubling of the chromosomes immediately after fertilization or more improbably by a union of two diploid gametes produced by the occurrence of a tetraploid sector in each of the two parent species.

Examination of the chromosomes at germ cell formation showed no lagging or single chromosomes, such as are found in the sterile F_1 hybrid produced by crossing *tabacum* with *glutinosa*.

Evidently the gametes of the new fertile form contain a haploid set of *glutinosa* chromosomes (12) plus a haploid set of *tabacum* chromosomes (24).

It is thus possible for a sterile F_1 species hybrid to become fertile and breed true for the hybrid condition by simple doubling of its chromosome number.

It is probable that *Primula Kewensis*, a garden species long known to florists, arose in a similar manner from the F_1 of *P. floribunda* (N=9) crossed with *P. verticilata* (N=9). The original F_1 was sterile but was maintained asexually. It later gave rise to a bud sport which was fertile and to which the name *P. Kewensis* was given. *Kewensis* is a reproduction of the F_1 type on a slightly enlarged scale. It was found to have 36 chromosomes in its cells instead of 18, the number in the cells of the sterile F_1 hybrid.

A different method for the origin of new chromosome numbers is found in species crosses in Crepis, a genus of the Compositae, and closely related to the common dandelion.

Crepis biennis (N=20) when crossed with *C. setosa* (N=4) produces a partially fertile F_1 hybrid which is predominantly like the *biiennis* parent. The hybrid has 24 chromosomes which at the time of germ cell formation produce 10 paired and 4 unpaired chromosomes. The 4 unpaired or single chromosomes are distributed at random to the poles of the cell at the reduction division. As a result the gametes of the hybrid may contain any number of chromosomes from 10 as the lowest possibility to 14 as the highest number, depending upon the number of single chromosomes which are included. We believe that the 10 pairs come from the 20 haploid chromosomes from *biennis*, while the 4 odd or single chromosomes are those from *setosa*.

By inbreeding F_1 plants of this cross there should be produced, theoretically, individuals with 10 pairs of chromosomes all from *biennis;* or 10 pairs from *biennis* with 1, 2, 3 or 4 pairs from *setosa*.

In order for any new type to have natural survival value it must first of all be fertile, it must be vigorous and hardy and it should breed true for its set of characters.

There are now under observation at the University of California, races derived from this cross which so far have to a large degree fulfilled the above requirements.

One race has 12 pairs of chromosomes; obviously 10 pairs from *biennis* and 2 pairs from *setosa*. It has some characters which are obviously from each parent species.

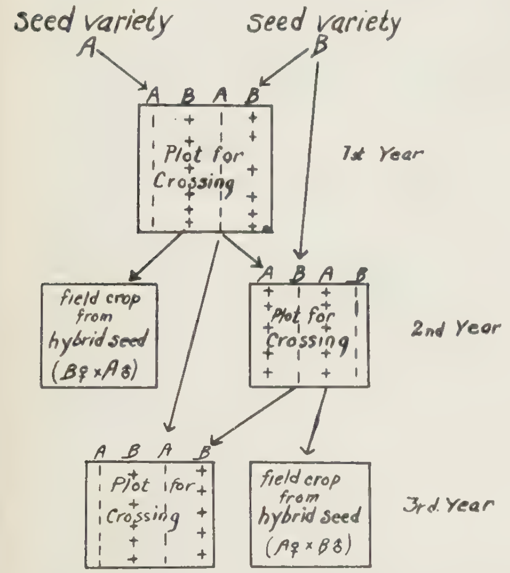
Other races appear to have 13, 14, and 15 pairs of chromosomes. There are some chromosome irregularities found in some of these races. In the race with 12 pairs of chromosomes there has been found one plant with 36 chromosomes, a triploid condition, one with 27 and two with 25 chromosomes in a group of 28 plants examined.

We are unable to estimate the significance or ultimate fate of such infrequent irregularities of the chromosome mechanism of these derived races, but we do know that similar irregularities have been found in some recognized species of plants.

Recent investigations concerning the causes and effects of variations in the chromosome content of plants and animals have been gratifyingly successful in important additions to our knowledge of the mechanism of heredity and the methods of evolution.

Chromosomes and Sex.

A considerable amount of genetic experimentation has been concerned with those characters by which we are able to distinguish the two sexes. Cytology has also played an im-



A diagram illustrating a method of producing hybrid seed corn. By alterating the variety detasseled each year and carrying over seed of the pure inbred variety for two years no extra seed plots are needed for keeping the two inbred pure varieties going. Crosses indicate detasseled rows on which hybrid seed is produced. Broken lines indicate rows producing pure seed for that variety.

portant part in developing the theories of sex inheritance.

It has been known for some time that the sex of an animal is determined at the time of fertilization by the kind of chromosomes present in the fertilized egg.

There are two principal types of mechanism of sex determination, both based upon the chromosomes.

The first is known as the insect type because it has been demonstrated most thoroughly in these forms. The other is known as the Avian type because it is found in birds.

In the insect type the female has two similar sex chromosomes and the male has two dis-similar sex chromosomes, one of which is identical with the female sex chromosomes.

The germ cells of the female all contain one of the two identical sex chromosomes but the sperm cells of the male are of two kinds in equal numbers. One kind of sperm contains the sex chromosome which is similar to that in the female and when this sperm fertilizes an egg cell a female is produced. The other type of sperm contains the odd sex chromosome and when it fertilizes an egg cell the result is a male. The sexes are produced in equal numbers because fertilization is a random process.

In the avian type the female contains the two dissimilar sex chromosomes and produces two kinds of eggs, while the male has two similar sex chromosomes. In other respects the system is similar to that found in insects.

In developing this theory for the determination of sex the geneticist has placed himself in a peculiar position.

A large amount of carefully checked genetic evidence has placed the inheritance of morphological and physiological characters upon a basis of genes located in definite portions of the different chromosomes. But those morphological and physiological characters which serve to distinguish the sexes have hitherto been explained upon a basis of a difference in whole chromosomes.

It is therefore gratifying to the ego of the geneticist when from a series of very unique and clever experiments evidence was obtained which puts the inheritance of sex on a basis of multiple genes.

These results came from a series of experiments started to find the cause of the appearance of a few individuals which were apparently partly male and partly female, known as intersexes.

In order to distinguish sex chromosomes from the remaining somes the latter are known as autosomes. and are alike in both females and males of a given species. A normal female has two similar sex chromosomes,

Showing size differences in a single litter of pigs due to heterosis. The second and third pigs from the right (✓) are pure bred Duroc Jersey and the others are F_1 hybrids between Duroc Jersey and Poland China. The hybrids averaged 49 pounds heavier than their pure bred litter mates. (from Roberts & Laible, in Jour. Hered.)

Normal female	=2 x chromosomes	+ 2	sets	of	autosomes.
" male	=1 x "	+ 2	"	"	"
Intersex	=2 x "	+ 3	"	"	"
Super female	= 3 x "	+ 2	"	"	"
Super male	=1 x "	+ 3	"	"	"

x and x and two sets of autosomes; the male has two dissimilar sex chromosomes, x and y, and two sets of autosomes.

The x chromosomes are found to contain an excess of genes for female characters, while the autosomes carry distributed among them a greater number of male-producing genes.

In a normal female the genes of the two x chromosomes overbalance the effect of the male genes of the autosomes and the characters of a female develop as a result.

In the male which has but one x, and a neutral y, the male-producing genes of the autosomes overbalance the genes of the one x chromosome and cause male characters to develop.

By changing the normal ratio of sex chromosomes and autosomes it is possible to shift the development of the sex characters in the direction of more femaleness or more maleness as is shown in the above table.

I have attempted in this short paper to sketch briefly some of the results of investigations which have shown the effects following changes in the chromosome numbers. It is quite apparent, however, that we have only begun to learn of the effects of changing the chromosome number. In connection with changes within a species we have had to work only with those forms upon which we have chanced by accident, because we were ignorant of the causes of these changes. By studying these results under controlled conditions we have been able to discover some means of inducing these changes. The regularity of the chromosome mechanism during cell division in plants can be disturbed by exposure to x-rays and to low temperatures at critical stages in germ cell formation. We are on the edge of a vast unexplored region in biology. Only a hint has been obtained of the great possibilities for new things which may come from this region in the future.

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RÉDACTEUR—H. M. NAGANT

Les Choux-de-Siam pour la production du lait, sont-ils économiques?

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La culture des choux-de-Siam est certainement payante si le cultivateur peut mettre les racines produites sur le marché pour l'alimentation humaine. Mais la demande est limitée.

Ce qui nous importe surtout, c'est de savoir si cette culture est payante lorsque les racines sont destinées à l'alimentation de la vache laitière. La réponse intéresse tous les cultivateurs de la Province de Québec.

La culture, sur nos fermes, converge vers la production laitière. Le cultivateur compte sur les revenus de la période de lactation de ses vaches pour faire face à ses dépenses générales et se faire quelques économies. Le but est le même partout, la production économique du lait, mais les méthodes diffèrent.

Sur la plupart des fermes, on se contente de faire la production du lait en été seulement. Les vaches, vêlées au printemps, passent l'été sur un pacage plus ou moins plantureux et, taries de bonne heure l'automne, hivernent avec une ration de foin, ou pour plus d'économie de fourrage, de foin et de paille.

Près des villes, les laitiers, vendant leur lait à meilleur compte, utilisent avantageusement les concentrés du commerce, ou les drêches de brasserie, et font la production du lait aussi bien en hiver qu'en été.

Aussi bon nombre de cultivateurs progressifs, bien que recevant des retours moins rémunérateurs pour leur crême ou leur lait qu'ils envoient aux beurreries, trouvent avantageux de prolonger la période de lactation de leurs vaches. Dans les régions plus chaudes de la province, ces cultivateurs emploient l'ensilage de blé d'Inde et complètent la ration avec un peu de concentrés, tandis que dans les régions plus froides, ils en sont réduits an foin et aux concentrés.

Nos agronomes, qui cherchent par tous les moyens à améliorer la situation économique du cultivateur, voudraient diminuer la dépense annuelle des concentrés du commerce et faire produire sur la ferme une alimentation toute aussi avantageuse pour le lait, mais revenant moins cher. Quelques-uns prônent comme moyen sauveur la culture des légumineuses, foin de trèfle, fourrage d'A.P.V. donné à l'état vert en été et à l'état sec en hiver. On tente même, un peu partout, la création souvent réussie de luzernières. D'autres veulent introduire en grand la culture des choux-de-Siam comme aliment complémentaire des rations de foin et de paille des diètes hibernales.

En ces derniers temps, il s'est élevé une discussion scientifique sur la valeur économique des choux-de-Siam dans l'alimentation complémentaire de nos vaches laitières. On demande: Sur quel rendement moyen de choux-de-Siam un cultivateur peut-il compter, quel est leur coût de production, quelle est leur valeur intrinsèque et complètent-ils bien la ration déficitaire des aliments ordinaires sur nos fermes?

Pour résoudre un problème de cette importance, d'où dépend la conduite économique de nos fermes spécialisées dans l'industrie laitière, il faut se baser sur autre chose

que les résultats partiels et plus ou moins contrôlés d'expériences d'une année, pouvant bien être la plus avantageuse pour cette culture, mais chercher dans les rapports officiels de nos fermes expérimentales les moyennes de production de plusieurs années, établir les coûts de ces cultures en ces mêmes années, et en ce qui concerne l'alimentation, comparer non seulement la valeur alimentaire des racines aux concentrés du commerce, mais aux autres aliments produits sur la ferme, en se basant sur les unités nutritives révélées par les analyses chimiques, et citer les plus probantes experiences faites sur les animaux.

* * *

Rendements

A la Ferme Expérimentale Centrale d'Ottawa le rendement moyen des racines, pendant 13 ans, a été de 22.2 tonnes à l'âcre, ce qui fait 18.8 tonnes à l'arpent.

Pour la même période de 13 ans, le rendement moyen chez tous les cultivateurs d'Ontario a été de 10.53 tonnes à l'âcre, soit 8.9 tonnes à l'arpent. (1).

A Cap Rouge, la récolte moyenne des rutabagas pendant 15 années consécutives a été de 11.8 tonnes à l'âcre, soit 10.0 tonnes à l'arpent. (2).

Sur les Fermes Expérimentales de l'Est du Canada, pendant les six dernières années, moyenne de 33 rapports, le rendement a été de 19.54 tonnes à l'âcre, soit 16.5 tonnes à l'arpent. (3).

Par conséquent, sur les fermes de nos cultivateurs, où les opérations culturales sont faites avec moins de soin que sur les Fermes Expérimentales, one ne peut guère escompter un rendement moyen supérieur à 10 ou 11 tonnes à l'arpent.

Coût de Production

Comme le prix de la main d'oeuvre était assez élevé pendant la guerre, nous basons les coûts de production sur les six dernières années, où la main d'oeuvre a été calculés à 22 centins l'heure sur les Fermes Expérimentales.

A la Ferme Centrale d'Ottawa, pondant les six dernières années, le coût moyen de production d'un âcre de racines a été de \$81.67, ce qui fait \$69.21 pour un arpent.

Sur les Fermes Expérimentales de l'Est du Canada, moyenne de 33 rapports, le coût de production s'est élevé à \$69.10 à l'âcre, soit \$58.56 à l'arpent. (3).

On peut dire que chez les cultivateurs les frais de production ne sont pas aussi élevés que sur les Fermes Expérimentales, mais les rendements sont inférieurs.

Le fait que cette culture exige beaucoup de travail manuel explique son coût élevé de production.

Ainsi, à Ottawa, ces six dernières années, il a fallu une moyenne de 173.2 heures de main d'oeuvre pour produire un âcre de betteraves, c'est-à-dire, 17.3 jours de travail à un seul homme.

Sur les Fermes Expérimentales de l'Est du Canada citées plus haut, il a fallu 143.9 heures de main d'oeuvre, soit 14.39 jours de travail à un seul homme. (3).

Pour dire que cette culture est aussi payante qu'une autre qui se fait en trois ou quatre fois moins de temps, elle devra laisser à son propriétaire un bénéfice net à l'âcre trois ou quatre fois plus élevé.

Il va sans dire aussi qu'un cultivateur, qui n'a pas de main d'oeuvre disponible, ne peut consacrer vingt-cinq à trente jours de travail, pendant la belle saison, à la culture de deux âcres de racines, sans que le reste de sa terre en souffre.

Si l'on tient compte des rendements, du coût de production et de la pauvreté des choux-de-Siam en matière sèche, (au laboratoire de Chimie d'Ottawa, sur une période de 17 ans, 582 échantillons de rutabagas venant d'une peu partout ont donné une moyenne de 10.7% de matière sèche.—Service de la Chimie, 1924) on peut conclure que les éléments nutritifs des choux-de-Siam sont dispendieux, souvent même plus dispendieux que ceux des concentrés.

A la Station Expérimentale de Cap Rouge, pour une moyenne de huit années consécutives, on a trouvé qu'une tonne de matière sèche de rutabagas Bonne Chance a coûté \$35.32; la tonne de matière sèche de l'avoine Bannière \$28.13 (la paille n'est pas comprise, cependant elle a sa valeur); la tonne de matière sèche du maïs Longfellow pour ensilage s'est élevée à \$25.75 et celle du foin de trèfle et de mil à \$8.04, déduction de 11% faite en raison de sa plus faible digestibilité. (2).

Est-il avantageux de remplacer les éléments nutritifs des concentrés par ceux des

plantes-racines qui coûtent souvent plus cher?

Valeur des Racines

Pour déterminer le prix des racines, on les compare généralement à d'autres aliments bien connus qui ont une valeur marchande. Quelques-uns prétendent qu'il faut les comparer aux concentrés du commerce, d'autres aux fourrages produits sur la ferme, d'autres, enfin, à l'ensilage de blé d'Inde. Cependant on arrive à des résultats assez différents, suivant le terme de comparaison que l'on prend.

Quoiqu'il en soit, la manière de procéder est la même: elle consiste à comparer les éléments digestibles contenus dans ces divers aliments, et pour faciliter la comparaison, on ramène les éléments digestibles sous forme d'unités nutritives. Pour trouver le nombre d'unités nutritives d'un aliment, on additionne les hydrates de carbone digestibles qu'il contient avec le gras et la protéine digestibles, multipliés par le facteur 2.3. (4).

Nous donnons ici l'analyse de quelques aliments bien connus qui peuvent servir de point de comparaison.

	1	2	3	4	5
Choux-de-Siam	1.0%	7.7%	0.3%	10.7%	1 a 8.4%
Betteraves	0.8	6.4	0.1	8.5	1 : 8.2
Son	12.5	41.6	3.0	77.2	1 : 3.9
Gru blanc	13.4	42.6	4.3	83.3	1 : 4.2
Orge	9.0	66.8	1.6	91.2	1 : 7.8
Avoine	9.7	52.1	3.8	83.0	1 : 6.3
Tourteau de lin ...	31.7	37.9	2.8	117.2	1 : 1.4
Luzerne	10.6	39.0	0.9	64.5	1 : 3.9
Trèfle	7.6	39.3	1.8	60.9	1 : 5.7
A.P.V.	9.2	36.9	1.8	62.2	1 : 4.4
Mil	3.0	42.8	1.2	52.4	1 : 15.2

1 Protéine digestible
2 Hydrates de carbone digestibles
3 Gras digestible
4 Unités nutritives
5 Relation nutritiive

Dans une tonne de choux-de-Siam il y a donc (10.7 x 20) 214 unités nutritives, tandis que dans une tonne de son il y en a (77.2 x 20) 1544. En se basant sur ces chiffres, les choux de Siam vaudraient $4.43 la tonne comparés au son à $32.00 la tonne. Si l'on prenait le même point de comparaison pour les autres produits de la ferme, on arriverait généralement à des prix plus élevés que ceux du commerce. Ainsi, comparé au son, le foin de luzerne vaudrait $26.73 et le foin de mil $21.71 la tonne.

Comparés au foin de trèfle évalué à $12.00 la tonne, les choux-de-Siam ne vaudraient que $2.10.

Par contre, si l'on admet que les choux-de-Siam valent $4.00 la tonne, on devra logiquement attribuer au fourrage d'A.P.V. séché une valeur de $23.11 et non pas de $8.00.

Cependant, il nous semble plus raisonnable de comparer entre eux des aliments de même nature, des succulents à des succulents, c'est-à-dire, les racines à l'ensilage de blé d'Inde. Et pour donner pleine justice aux racines, le meilleur procédé est bien de faire des expériences sur les animaux qui pourront utiliser non seulement leurs principes nutritifs, mais aussi faire valoir leur succulence. C'est cette méthode que l'on a suivie ces dernières années à la Ferme Centrale d'Ottawa, où l'on a fait des expériences directes sur un troupeau d'une vingtaine de vaches de différentes races, pour déterminer la valeur relative des racines et de l'ensilage de blé d'Inde.

On a trouvé, pour une moyenne de trois années, lorsqu'on fournissait toute la succulence de la ration sous forme de racines, que celles-ci valaient $1.83 la tonne comparées à l'ensilage de blé d'Inde évalué à $3.02 (coût de production). En d'autres termes, ces expériences révèlent que les racines, employées en assez grande quantité,

ne valent que soixante pour cent de l'ensilage pour la production du lait.

Lorsqu'on a donné la succulence moitié sous forme d'ensilage et moitié sous forme de racines, on a trouvé que celles-ci avaient une valeur un peu plus élevée, c'est-à-dire, $2.24 la tonne comparée à l'ensilage au prix de production $3.07. En d'autres termes, ces expériences démontrent que les racines, données en quantité limitée, valent soixante-treize pour cent de l'ensilage de blé d'Inde pour la production du lait. (5).

On peut donc affirmer en toute sûreté que les racines ne peuvent rivaliser avantageusement avec le blé d'Inde dans les régions où celui-ci vient bien. Dans son rapport de 1922, l'Agriculteur du Dominion nous dit qu'à Ottawa, les betteraves fourragères, pendant les douze dernières années, ont accusé une perte moyenne de $22.21 par âcre. "Il n'y a pas une seule année pendant toute cette période, ajoute-il, où les betteraves aient laissé un bénéfice. Il est bon également de tenir compte du fait que la production moyenne des betteraves a été de 21.1 tonnes par âcre, ce qui est un rendement très satisfaisant, bien supérieur à la production moyenne dans la province. Il semble évident, à en juger par les résultats de cette étude du prix de revient, qui a été conduite avec le plus grand soin pendant bien des années, que les betteraves ne sont pas une récolte avantageuse là où le blé d'Inde vient bien."

Mais peut-on dire la même chose des régions plus froides où l'on ne peut récolter le blé d'Inde? Certains prétendent que, dans ces régions, les choux-de-Siam sont l'aliment tout désigné pour compléter une ration de mauvais foin. Ces messieurs oublient qu'une vache laitière, pour donner un bon rendement, a besoin d'une alimentation assez riche en matière azotée, c'est-à-dire, d'une alimentation dont la relation nutritive soit de 1 à 5 ou de 1 à 6. Or les choux-de-Siam, étant eux-mêmes trop pauvres en protéine pour constituer un aliment bien balançé pour la vache laitière, ne pourront donc pas corriger le même défaut, plus accentué encore, dans le foin de mil. Aussi du foin de mil et des racines constitueront toujours une ration médiocre pour la production du lait.

L'expérience suivante faite sur de jeunes bovins en croissance, qui ont besoin d'une alimentation aussi riche en matière azotée que les vaches laitières, illustre bien ce que nous venons de dire. (6). Ces jeunes bovins, recevant comme nourriture 8 kilogrammes de betteraves, 3 kilogrammes de bale et 3.6 kilogrammes de paille d'avoine et de blé, ont accusé une croissance moyenne journalière de 33 grammes. Avec pareille ration, l'augmentation en poids d'un kilogramme s'est élevée à 77 francs. Lorsqu'à cette ration on a ajouté 1.6 kilogramme de tourteau, la croissance moyenne journalière a été de 666 grammes (20 fois plus grande), ce qui a ramené le prix de revient d'un kilogramme à 7. fr 41, c'est-à-dire, dix fois meilleur marché.

A la Station Expérimentale de Sainte-Anne de la Pocatière, on a fait ces dernières années des expériences d'alimentation avec de l'ensilage, des racines et du fourrage d'A.P.V. séché, pour déterminer lequel de ces trois aliments dans la région peut produire le lait de la façon la plus économique. (7). Il va sans dire que dans ces expériences les rations étaient bien équilibrées.

Le coût de production de 100 livres de lait, pour une moyenne de quatre années, s'est élevé aux prix suivants: ensilage, $1.18¾; racines, $1.16½; A.P.V., $1.11¾. Dans ces expériences, l'ensilage, les racines et l'A.P.V. ont été calculés au coût de production. Inutile d'ajouter que l'ensilage récolté à Sainte-Anne de la Pocatière est souvent de qualité inférieure parce que la saison de végétation est trop courte. Si le fourrage d'A.P.V. est arrivé en tête, c'est parce que, dans le district, on peut le produire d'une manière plus économique que l'ensilage et les racines.

Donc, dans les régions où le blé d'Inde ne vient pas, les racines n'ont pas pour cela une plus grande valeur nutritive en elles-mêmes, n'ont pas la faculté de transformer les hydrates de carbone en protéines, ni ne coûtent meilleur marché à produire. Néanmoins, distribuées en petite quantité dans une ration bien équilibrée, mais manquant de succulence, elles produisent des effets bienfaisants qui rendent leur emploi avantageux. Dans ce cas, elles ont une valeur plus élevée que ne l'indique leur teneur en principes digestifs. En communiquant une saveur spéciale à la ration, elles disposent l'animal à mieux utiliser les autres aliments, et maintiennent son organisme dans un bon état de fonctionnement.

"Ce qui constitue l'économie de leur emploi dans l'alimentation de nos vaches, dit le professeur Godbout, c'est l'effet avantageux qu'elles ont sur le système digestif de ces animaux; et dans le cas des vaches dont la production laitière ne dépasse guère 20 livres par jour et dont l'alimentation doit être proportionnée à cette production, cet effet particulièrement bienfaisant des racines est pleinement obtenu lorsque nous en donnons les quantités de 15 à 20 livres par jour." (8).

Il faut citer encore à l'avantage des racines que les nombreux travaux que cette culture exige, s'ils sont bien faits, améliorent le sol pour les récoltes suivantes, mais il ne faut pas oublier que ce sont les légumineuses et non les légumes qui ont la précieuse faculté d'enrichir le sol en azote.

Conclusions

A la suite de ces trop longues considérations, il faut tirer les conclusions qui s'imposent et qui peuvent nous servir à solutionner les problèmes qui se posent journellement sur nos fermes québéquoises.

En tout premier lieu, il faut admettre que la matière azotée est essentielle pour la production du lait. Malheureusement c'est cette matière qui fait le plus défaut sur nos fermes et qui se vend le plus haut prix sur le marché.

Il faut donc en venir tout de suite à la culture sur la ferme d'aliments riches en protéines.

1—Pour aller au plus pressé, il faut conseiller la culture des fourrages verts (A.P.V.) pour fournir dès les mois d'été un complément aux herbages durcis, et servir le surplus, emmagasiné comme foin sec, comme diversion au régime actuel des fourrages grossiers pendant la saison d'hiver.

2—Encourager de toute manière la culture du trèfle, comme pâturage et comme fourrage pour la production du lait. Continuer la campagne pour la production de la graine de trèfle, non pas seulement pour la vente, mais pour l'ensemencement des prairies et des futurs pâturages. Apprendre aux cultivateurs à bien traiter le foin de trèfle, à l'engranger dans les meilleures conditions possibles et le servir aux vaches laitières et non aux chevaux.

3—Augmenter les essais de luzernières qui se font un peu partout. Encourager la semence de cette légumineuse, en mélange avec les autres graines de foin et aussi seule sur les meilleurs endroits de la ferme, avec de la pierre à chaux comme amendement. Si l'on réussit à introduire dans la province la culture de la luzerne, à produire une graine résistante qui assurera un fourrage commun pour les vaches laitières, notre succès en industrie laitière est assuré. Du coup, on fera économiser l'achat de concentrés dispendieux, nécessaires aujourd'hui pour balancer nos rations déficitaires en matières azotées.

4—Lorsque le cultivateur aura réussi à enrichir la ration de ses vaches en matières azotées, il trouvera avantage à leur donner des racines, car les racines, tout en étant dispendieuses à produire, peu nutritives en elles-mêmes, aideront à la digestibilité des autres aliments et à leur plus complète assimilation.

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Convention Annuelle de la C.S.T.A.

par Roger Gagnon

Un voyage d'étude sur la coopération, dans l'Ouest canadien, m'a fourni l'occasion d'assister à la convention annuelle de la C.S.T.A., qui se tenait à Vancouver, du 16 au 18 juin dernier.

Sans vouloir devancer le rapport annuel, il me fait plaisir de donner à la section française de la revue un résumé succinct de ce que fut notre convention de 1927.

Il est certainement malheureux qu'un plus grand nombre de membres ne puissent pas assister à nos conventions; pour ma part, c'était la première fois qu'il m'était donné d'y assister, et je fus agréablement impressionné par le ton des discussions, aussi bien que par les sujets traités et l'attention donnée par les membres présents.

Nous avons pu, comme le dit le secrétaire, dans la revue de juillet, juger que "notre association a aujourd'hui acquis une place permanente dans l'Agriculture canadienne, et devient de plus en plun un corps professionnel digne, influent et utile."

L'association compte actuellement 1,000 membres; ce nombre augmentera nécessairement.

Parmis les nombreux rapports soumis par les divers comités, tous très intéressants, et qui seront publiés en entier sous peu, je crois, il convient de mentionner tout particulièrement celui du comité sur "La Coordination des politiques agricoles", présenté par le Doyen E. A. Howes. Ce rapport, très important, puisqu'il étudie les relations entre les Ministères Fédéral et Provinciaux d'Agriculture, est rempli d'heureuses suggestions qui devraient être fort utiles pour une plus grande coopération entre ces divers corps publics d'enseignement agricole. Je n'ai aucun doute que ce rapport sera reçu par tous les membres avec beaucoup d'intérêt.

Les conférences des Docteurs Bailey et Collins ont été des plus intéressantes. Le premier traita de la "Rouille des grains", et le second, de la "génétique".

Parmi les innovations décidées durant la convention, il est à propos de mentionner la souscription des membres à vie.

Ceux qui désireraient faire une souscription permanente (chose bien désirable), pourront payer au secrétaire un montant de $100.00. Il est entendu que ses souscriptions de membres à vie formeront un fond de réserve "inviolable" et contribueront à former un capital-actif qui assurera à la Société, dans l'avenir, un revenu annuel substantiel.

Il est donc à souhaiter que tous ceux qui veulent se libérer par anticipation de leurs dus annuels à la Société le fassent le plus tôt possible.

La huitième convention annuelle sera tenue à Québec en juin 1928.

Nous attendons, à cette occasion, une des plus grosses assistances jamais atteintes encore dans une convention de la C.S.T.A.

Nous comptons aussi que tous les membres des diverses sections de Québec contribueront pour leur part au succès de cette réunion.

L'hospitalité canadienne française est proverbiale; mais il faudra faire encore plus qu'à l'ordinaire si nous voulons rendre ce que l'on a fait pour nous cette année en Colombie Anglaise.

Le président actuel de la Société, notre ami, Monsieur L. P. Roy, a fait honneur, comme on devait s'y attendre, non seulement à sa profession, mais aussi à sa race et à sa province. Il est, à mon point de vue—et ceci est partagé par un grand nombre de confrères anglais et français—un président idéal possédant parfaitement les deux langues, maître de lui-même; il a dirigé les délibérations des séances avec tact et maîtrise.

Je n'ai aucun doute que, sans sa direction, la convention de l'an prochain restera un fait mémorable dans les annales de l'association.

Notre dévoué secrétaire, Fred. H. Grindley, a été réengagé pour l'année.

Je ne voudrais pas terminer ce résumé sans dire un mot de l'heureuse initiative prise par la C.S.T.A. et la C.S.G.A., de tenir leurs conventions conjointement. Ces deux associations ont un but identique: les études agricoles scientifiques et leurs réunions conjointes procurent à leurs membres l'avantage de se mieux connaître et de profiter d'une semaine d'études scientifiques des plus utiles.

La C.S.G.A. se réunira donc à Québec, l'an prochain.

INDEX TO VOLUME VII

ARTICLES

English Articles

Articles Français

AUTHORS

Vol. 7
1926-27